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EDITED BY J. McKEEN CATTELL

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A Remarkable Textbook

Barber's First Course in General Science

By FREDERICK D. BARBER, Professor of Physics in the Illinois State Normal University, MERTON L. FULLER, Lecturer on Meteorology in the Bradley Polytechnic Institute, JOHN L. PRICER, Professor of Biology in the Illinois State Normal University, and HOWARD W. ADAMS, Professor of Chemistry in the same. vii+588 pp. of text. 12mo. $1.25.

A recent notable endorsement of this book occurred in Minneapolis. A Committee on General Science, representing each High School in the city, was asked to outline a course in Science for first year High School. After making the outline they considered the textbook situation. In this regard, the Committee reports as follows:

"We feel that, in Science, a book for first year High School use should be simple in language, should begin without presupposing too much knowledge on the part of the student, should have an abundance of good pictures and plen[illegible] of material to choose from.

Barber's *First Course in General Science* seems to us to best meet these requirements and in addition it suggests materials for home experiments requiring no unusual apparatus, and requires no scientific measurements during the course. We recommend its adoption."

Other Interesting Opinions on the Book Follow:

SCHOOL SCIENCE AND MATHEMATICS:—It is one of the very best books on general science that have ever been published. The biological as well as the physical side of the subject is treated with great fairness. There is more material in the text than can be well used in one year's work on the subject. This is, however, a good fault, as it gives the instructor a wide range of subjects. The book is written in a style which will at once command not only the attention of the teacher, but that of the pupil as well. It is interesting from cover to cover. Many new and ingenious features are presented. The drawings and halftones have been selected for the purpose of illustrating points in the text, as well as for the purpose of attracting the pupil and holding his attention. There are 375 of these illustrations. There is no end to the good things which might be said concerning this volume, and the advice of the writer to any school board about to adopt a text in general science is to become thoroughly familiar with this book before making a final decision.

WALTER BARR, *Keokuk, Iowa*:—Today when I showed Barber's Science to the manager and department heads of the Mississippi River Power Co., including probably the best engineers of America possible to assemble accidentally as a group, the exclamation around the table was: "If we only could have had a book like this when we were in school." Something similar in my own mind caused me to determine to give the book to my own son altho he is in only the eighth grade.

G. M. WILSON, *Iowa State College*:—I have not been particularly favorable to the general science idea, but I am satisfied now that this was due to the kind of texts which came to my attention and the way it happened to be handled in places where I had knowledge of its teaching. I am satisfied that Professor Barber, in this volume, has the work started on the right idea. It is meant to be useful, practical material closely connected with explanation of every day affairs. It seems to me an unusual contribution along this line. It will mean, of course, that others will follow, and that we may hope to have general science work put on such a practical basis that it will win a permanent place in the schools.

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THE SCIENTIFIC MONTHLY

OCTOBER, 1917

APPLICATIONS OF SCIENCE TO WARFARE IN FRANCE

By GEORGE K. BURGESS, Sc.D.,

PHYSICIST AND CHIEF OF DIVISION OF METALLURGY, BUREAU OF STANDARDS

THE chemists say this is the chemists' war, the engineers claim it as theirs, while a distinguished French physicist calls the struggle "a grandiose physical phenomenon," and the medical and surgical fraternity demonstrate their prevention from epidemics and rendering possible the return to the front some three fourths or more of all invalided and wounded has made the continuance of trench warfare possible.

Verdun has been named "the metallurgical battle" and also "the battle of the trucks," referring in the first case to the importance of the iron ore deposits of the Briey region located a few miles to the northeast and in the second to the vast numbers of automobile trucks employed by the French on the only highway open at the outbreak of the battle, namely, that connecting Bar-le-Duc with Verdun.

The meteorologist is listened to with attention by the Great Headquarters, as was the astrologer of yore, before an extensive offensive is undertaken; and the geologist is consulted for information as to where to halt and dig in, where shelters may be safely built and as to the probability of underground waters. Even the astronomer's services are considered of great importance, for example, in the preparation of new artillery tables and maps, the improvement and invention of instruments, which differ but slightly in principle, however much they may differ in the nature of their use, from those with which he is familiar. Again, the statistician is a most valuable person when an offensive is being planned. Also the mathematician France, at least, has found indispensable, for in the person of M. Painlevé he sits at the head of them all as minister of war, whose civil, technical staff is largely made up of eminent mem-

bers of the same profession. Is this then a mathematicians' war?

In truth, chemistry, physics, hygiene, mathematics, engineering, geography and geodesy, metallurgy, geology, bacteriology, meteorology, or pretty much the whole curriculum of physical and natural sciences, and their applications, are each of them fundamentally essential in modern warfare, some of course more apparently so than others, but almost none could be spared and the war carried on successfully.

Two most important corollaries immediately suggest themselves:

First, the war can not be successfully prosecuted if there is lacking any of the necessary raw materials including chemical, physical and metallurgical supplies such as nitrates, optical glass, coal and steel, to name but a few. The operations of modern warfare are so complex and interrelated that the want of crucial supplies in one domain may seriously hamper all; hence the phenomenon of which there are instances innumerable, of intensive scientific research in the development of substitutes as one or another essential material becomes scarce. There is many an interesting memoir in this field awaiting the end of the struggle to see the light.

Second, modern warfare can be waged successfully only by the proper organization of these diverse scientific elements in addition to, and coordinated with or incorporated in, the military establishments.

In a completely mobilized country, such as France, it is essential that each man in the community, which is nearly identical with the military establishment, be assigned to the task for which he is best fitted—or there must be scientific organization and management to secure the country's greatest possible efficiency.

What is this organization? how and to what extent are the sciences used in warfare? and how are the scientific men mobilized or otherwise made use of? The complete answers to such questions can not be expected in so short a space.

It was the writer's privilege to be one of a scientific mission sent abroad by the National Research Council, immediately after America's entry into the war, for the purpose, among others, of finding answers to the above questions. A brief statement of some of the impressions gained during a three months stay in England and France may not be without interest. Our mission had extraordinary if not unique opportunities for close observation of all the aspects of science in warfare, not only

from many interviews, visits to laboratories, manufacturing plants, and technical ministerial bureaus, but also from inspection at the fronts of the French and British armies of the organization, application and actual operation of the scientific and technical services, all of which were shown and explained to the most minute detail.

The most striking impression brought home is one of unity of purpose, perfect adaptation and coordination of the several branches, a harmonious whole, in fact, made up of separate and often highly intricate parts constituting an organization in which all the sciences and their applications blend into one, which is focused by the admirably trained technical and staff officers on the sole object of destroying the enemy. The French traits of individuality, initiative, and self-reliance are, however, in no sense lessened or dulled by this cooperation.

What are some of the component parts of this unity in scientific warfare? We shall mention but a few in illustration of the whole. Let us first consider examples of the applications of physics to warfare, some of which owe much of their efficacy to the relative immobility of the front.

Of all the branches of this science the one that had in recent years been lagging behind the others and to whose development the least attention was being paid, was acoustics; yet it is not an exaggeration to say that the application of the principles of acoustics, or sound, is of the greatest importance at the front.

One of the most highly developed is the location of enemy guns, concerning the details of which a volume could be written; suffice it to say that in the French armies there are several systems in use, all of which will locate to within a few yards an enemy battery at ten or twenty kilometers, indicate the caliber of the guns, differentiate between the sounds of discharge, flight through the air and bursting, and record each and every separate shot; and the spot from which the shot was fired may, under certain conditions, be located before the shell bursts. There have been developed several ingenious listening devices built on entirely different acoustical principles for use in mine warfare, by means of which enemy mining operations may be exactly located. Again for the location of sounds in the air, especially useful, for example, in locating airplanes at night, several new types of sound apparatus of extreme sensitiveness are in use. For submarine detection, some of the most promising methods for further improvement are based on the use of still other sound detecting devices. Wonderfully powerful megaphones for use in battle have also been developed.

Acoustics as an active branch of physics has most decidedly come into its own.

What about optics? One would expect this branch to show perhaps the highest developments and most interesting applications. Relative to acoustics, however, optics takes second rank as to new developments, although there are to its credit many beautiful modifications and improvements and not a few entirely new instruments, and the output of optical instruments is enormous. Optical signalling or observation, however, is not depended upon alone in battle, although several types are in use.

In photography and the technique of photographic map making there have been great improvements, brought about directly by military necessity, especially in aerial photography, apparatus and interpretation. One of our most interesting visits at the front was to the photographic headquarters of a French army corps, where we listened to an admirably delivered, illustrated lecture on the taking and interpretation of aerial photographs. There are at the front schools for training balloon observers, who have to reconstruct maps from their perspective photographs; certain of the aviators are similarly trained, although the making of maps from the photos they take is mainly the work of a special branch of the service. The art of map making from photographs, as carried out at the front, is practically a new branch requiring great skill, and is evidently of the first importance, as oftentimes the success of an offensive is largely dependent upon the quality of this work. These special services for which there are schools, are recruited from the army by competitive examinations, thus automatically obtaining the personnel best adapted.

As would be expected there have been not a few advances made in applications of electricity, especially wireless apparatus and methods, signalling and listening devices. There may be, for example, during a battle more than 1,500 separate wireless stations sending messages simultaneously; provision is successfully made for preventing interference and sorting out this great mass of signals so as to avoid confusion. Portable wireless outfits are supplied by the tens of thousand—requiring for the construction of these instruments alone a veritable army of skilled mechanics.

The reading public is, perhaps, more familiar with some of the applications of chemistry to warfare, such as the asphyxiating, tear-producing and other noxious gases used in waves or clouds and lately more and more in shells; and the importance

of nitric acid, toluol and the like has been impressed on every one. The stupendous scale on which such substances must be produced to keep up with the demands of the armies is perhaps not sufficiently realized, nor is there any adequate appreciation of the amount of scientific investigation being carried out. In France I understand there are some twenty-five distinct laboratories engaged in nitrogen fixation research alone.

Turning now to meteorology, what has the weather man to do with war? He too plays a capital rôle. With his sounding balloons he keeps the troops informed as to when a gas attack may be expected and when it would be profitable to start one; the artillery depend on him for data to calculate important corrections, as for wind, humidity, pressure, and temperature and upper air conditions in sighting their guns; the aviators as to prevailing winds, especially high up, and for general weather conditions; the balloon men keep in close touch with him, and even the transport service depends upon him for advance information as to muddy roads; headquarters relies upon him for knowledge of impending fog or rain and other changes—the weather man has a very heavy responsibility in helping to decide the most propitious moment for an attack on a grand scale, and if his forecast is erroneous, disaster may result. There is a special meteorological service—in fact there are two in addition to the regular service of peace times—attached to the French armies and linked to the British. The personnel, as in all the French services, is of the highest order of ability, being recruited largely from the professions and trades which depend upon the weather.

One of the most impressive sights we were permitted to witness at the French front was the firing of a battery of 320 mm. (13 inch) cannon, mounted on railway trucks, at an invisible target 19.5 kilometers distant. It took four shots to accomplish the end sought, which was demolishing an enemy battery that had been located the day before by "sound ranging" and photography.

What does such an operation mean in preparation and execution, viewed as a scientific experiment?

In the first place it presupposes an exact knowledge of the region expressed in accurate maps, including of course territory in possession of the enemy—the preparation of these maps is one of the most elaborate of the technical geographic services of the army; this service is usually supplemented when possible by triangulation from fixed observatories, and photographic mapping from airplanes or balloons; it assumes, further, that

the cannon of the battery have, as we might say, been calibrated, that is the characteristics of their firing determined by shooting at a recognized and exactly located object of about the same range and making a known angle with the target; the relative positions of battery and target and their exact distance apart should also be known. A big gun is displaced somewhat with every shot fired and is brought back to position by reference to a fixed base by means of a series of optical measurements. Some of the allowances and corrections that have to be made in firing are: variations in weight of projectiles—showing the need of uniformity, homogeneity and geometrical exactness in their manufacture, not a simple matter; weight, quality, age and temperature of the firing charge—which gives but a hint as to a most elaborate series of researches in the physical chemistry of ballistics; the age, state of erosion and temperature of the gun—another series of unsolved problems; the numerous atmospheric corrections such as direction and force of the wind at the various levels of the trajectory, the temperature, pressure, and humidity of the air, all of which produce disturbances that vary with the distance of the target or what is the same, muzzle velocity of the shot as well as the shape of the shell.

There have been prepared elaborate tables containing these corrections and others which are constantly being improved by further research; the theory of probabilities is also made use of in an elaborate way for each caliber to control the inevitable dispersion of the shots after all known corrections are made. With all these data, how does the artillery officer know the accuracy of his fire at a target invisible to him and 20 kilometers away? If he has the local mastery of the air use is made of airplanes which signal the location of each shot, otherwise he must depend on stationary balloons, special observatories or even on his calculations alone if the weather be bad.

Finally, it is not necessary merely for the shot to strike the target, it must explode at the right instant and have a suitable "fragmentation"—here is opportunity for more research in mechanics, chemistry, and metallurgy. It may be stated in passing, the French were compelled to develop a modified cast-iron or semi-steel shell, as they could not obtain enough steel for shells the first year of the war. It is not necessary to state that they succeeded in this.

Such in brief is the mechanism of artillery fire, for the accomplishment of which many of the sciences collaborate, and for the rendering it more exact there is still room for considerable research in astronomy, geodesy, metallurgy, chemistry,

physics, and meteorology. The battery we visited demolished the 20-kilometer-distant target at the fourth round, as was shown from photographs taken before and after firing—nothing is left to chance.

Turning to aviation, we need not dwell upon the wonderful advances that have been made in design of planes and motors, all of which has been dependent largely upon scientific investigation of the highest order, and numerous and varied are the research establishments, both governmental and private, for their execution. Here again one is impressed by the magnitude and grandiose scale on which this highly intricate and beautiful branch of the service has been developed. The scientific instruments alone with which the avions are equipped, say five types to a machine on the average, meant the development of an important technical industry in the products of which improvements are made almost daily.

We have not touched upon the applications of science in the various branches of military engineering, some of which are new in this war, requiring the highest directing, technical talent and thousands of workmen; the advances in medicine, sanitation and surgery have not been treated, nor have we mentioned trench warfare with its manifold engines, appliances and materials, necessitating the creation of new industries accompanied in all cases by elaborate scientific research. Gas warfare alone is based on what is literally a stupendous industry requiring the employment of chemists and other scientifically trained men on a great scale. Again there are large and very active laboratories maintained for the examination of enemy munitions and appliances of all kinds, and for the development of new and improved types.

A matter of vital importance is maintaining the quality and standards of the munitions supply, and this is done only by constant vigilance of the inspection and designing forces among which are many specialists of the highest grade and the total number engaged in this work amounts to many thousands. There is nothing so disastrous to the morale of the troops in battle as premature shell explosions. The quality of the steel must be beyond reproach. Here, as elsewhere, the United States will do well to profit from the European experience. The methods of steel casting as ordinarily practised in America are not considered abroad as entirely satisfactory for the production of "sound steel" from which shells, and especially high explosive shells, should be made. I had opportunities to visit several British and French steel works and shell plants, and my

observations confirm this belief, namely, that speaking broadly, the European steel-ingot casting practise is superior to ours, and I may add they consider theirs none too good.

For utilizing to best advantage the many suggestions and inventions that are proposed, there have been established, in Great Britain and France, inventions bureaus, to which are attached men of eminence in science and engineering. The most promising ideas are tried out under competent direction, and in some cases the board itself initiates and executes investigations of great military interest. Applications for patents may be held in abeyance and kept secret on the advice of this board.

A word now as to the organization of the scientific and technical services. Both the British and French, early in the war, saw the advantages to be gained by separating the fighting from the supply departments, hence the creation in each country of a ministry of munitions. It might almost be said that the able-bodied inhabitants of France belong to either the war or munitions ministry; or in other words the population is organized for war. The fundamental principle involved in this organization is that each shall do that for which he is best fitted in the national work of destroying the enemy. This principle admitted, the solution for any particular individual is a relatively simple matter; it is necessary of course for the administrative heads and military chiefs to exercise good judgment in the balancing of the organism as between military and industrial service.

Men most competent to give advice, such as the members of the Academy of Sciences, are asked for advice and they sit, as individuals or as representing the Academy, in an advisory capacity on many important committees. Men who have an aptitude for research are put to work in one or another of almost innumerable laboratories on problems of military importance.

Examples enough have been given to impress upon the reader, I hope, the tremendous magnitude, enormous scope and far-reaching extent of the problem of modern warfare looked at from the point of view of the applications of science and the employment of scientific and technical men.

The wonderful French organization was not all built up in a day, neither were mistakes avoided nor could all the developments that have taken place been foreseen. In the early days of the war men were sent to the front whose brains to-day would be an invaluable asset; national laboratories were almost

depopulated; the military authorities were indifferent to advice from civilian specialists. To-day one would be embarrassed to decide whether an officer in one of the specialized services was an officer before the war or, let us say, a professor of chemistry. The national laboratories have been multiplied ten-fold; and such care is now taken to protect productive brains that it may happen that the inventor of a new device is not allowed to go to the front to try it out.

In conclusion, I am tempted to quote the scientific definition of this war as given by a distinguished Belgian officer in the French service. The early incursions of the Germans were for the visible supplies of potential energy above ground—the cereals; the present war is their attempt to gain control of the sources of invisible potential energy below ground—coal and iron; and the next may be caused by their thirst for the sources of kinetic energy—the waterfalls.

FOOD IN WAR TIME[1]

By Professor GRAHAM LUSK

CORNELL UNIVERSITY MEDICAL COLLEGE

THERE is no doubt that under the conditions existing before the war the American people lived in a higher degree of comfort than that enjoyed in Europe. Hard times in America have always been better times than the best times in Europe. As a student in Munich in 1890 I remember paying three dollars a month for my room, five cents daily for my breakfast consisting of coffee and a roll without butter, and thirty-five cents for a four-course dinner at a fashionable restaurant. This does not sound extravagant, but it represents luxury when compared with the diet of the poorest Italian peasants of southern Italy. Two Italian scientists describe how this class of people live mainly on cornmeal, olive oil and green stuffs and have done so for generations. There is no milk, cheese or eggs in their dietary. Meat in the form of fat pork is taken three or four times a year. Cornmeal is taken as "polenta," or is mixed with beans and oil, or is made into corn bread. Cabbage or the leaves of beets are boiled in water and then eaten with oil flavored with garlic or Spanish pepper. One of the families investigated consisted of eight individuals, of whom two were children. The annual income was 424 francs or $84. Of this three cents per day per adult was spent for food and the remaining three fifths of a cent was spent for other purposes. Little wonder that such people have migrated to America, but it may strike some as astonishing that a race so nourished should have become the man power in the construction of our railways, our subways and our great buildings.

Dr. McCollum will tell you that the secret of it all lies in the green leaves. The quality of the protein in corn is poor but the protein in the leaves supplements that of corn so that a good result is obtained. Olive oil when taken alone is a poor fat in a nutritive sense, but when taken with green leaves these furnish that one of the peculiar accessory substances, commonly known as vitamines, which is present most abundantly in butter fat, and gives to butter fat and to the fat in whole milk its dominant nutritive value. The green leaves also fur-

[1] An address prepared at the request of the U. S. Food Administration.

nish another accessory substance which is soluble in water and which is necessary for normal life. Furthermore the green leaves contain mineral matter in considerable quantity and in about the same proportions as they exist in milk.

Here then is the message of economy in diet, corn the cheapest of all the cereals, a vegetable oil cheaper by far than animal fat, which two materials taken together would bring disaster upon the human race, but if taken with the addition of cabbage or beet tops they become capable of maintaining mankind from generation to generation. One can safely refer to such a diet as a balanced diet.

This preliminary sketch shows several important fundamentals of food and nutrition. If one gives an animal a mixture of purified food stuffs, pure protein, pure starch, purified fat, and a mixture of salts like the salts of milk, the animal will surely die. But if one substitutes butter fat for purified fat, and adds a water solution of the natural salts of milk, the animal lives and thrives.

Again the illustration shows how corn may be so supplemented with other food-stuffs as to become extremely valuable in nutrition. It is especially valuable at the present time because corn is comparatively cheap and plentiful. But one asks how about pellagra? It must be here definitely stated that the use of cornmeal is not the cause of pellagra provided the right kind of other foods be taken with it. Pellagra occurs in the "corn belt" of the United States, and especially among the poorer classes in the south. The disease has developed since the introduction in 1880 of highly perfected milling machinery which furnishes corn and wheat completely freed from their outer coverings. In Italy, where the milling of corn is still primitive, pellagra is not as severe as with us, because the corn offal is not completely removed and this contains the accessory food substances or vitamines which are essential to life. Pellagra is generally believed to be produced by a too exclusive use of highly milled corn and wheat flour in association with salt meats and canned goods, all of which are deficient in vitamines. The administration of fresh milk is naturally indicated. Goldberger states that after the addition of milk to the diet of a pellagrin, the typical clinical picture of pellagra no longer persists. The poor in the mill towns of the South lived too exclusively upon a corn diet without admixture of milk or fresh animal food or even of cabbage and pellagra has been the consequence.

The Food Administrator asks us to eat corn bread and save the wheat for export. It is a very small sacrifice to eat corn

bread at one meal or more a day. Indian corn saved our New England ancestors from starvation, and we can in part substitute it for our wheat and send the latter abroad to spare others from starvation. The simplest elements of patriotism demand that we do this. Therefore let us cry "Eat corn bread and save the wheat for France, the home of Lafayette!"

Another point in war economy is the use of whole milk in greater quantity, and the diminution of the use of butter and cream. Cream is bought only by the wealthy, but in sufficient volume to largely reduce the amount of whole milk available. In Germany before the war 15 per cent. of the milk supply of that country was used for the production of cream. Regarding the use of butter a Swiss professor, himself an expert in nutrition, complains that whereas in his youth children were never given butter on their bread for breakfast, not even when there was no jam in the house, yet to-day absence of butter from the table is held to be indicative of direst poverty.

If one takes a pint of whole milk daily, or even, as we have seen, cabbage or beet tops in its stead, one may take fat in the forms of oleomargarine, olive oil or cotton-seed oil without possible prejudice to health. The legal restrictions placed upon the sale of oleomargarine and the taxes enhancing its cost, now in operation in many of our states, are without warrant in morals or common sense and should be entirely abolished in times like these. A well-made brand of oleomargarine is much more palatable than butter of the second grade, and certainly for cooking purposes is just as valuable.

Whole milk contains everything necessary for growth and maintenance, protein, fat, milk-sugar, salts, water and the unknown but invaluable accessory substances. It is of such prime importance that each family should have this admirable food, that I have suggested that no family of five should ever buy meat until they have bought three quarts of milk. The insistence by scientific men upon the prime importance of milk has probably had something to do with its rapid enhancement in price. This latter factor is greatly to be regretted. I have often wondered why it was that a quart bottle of a fancy brand of milk in New York should cost about as much as a quart of *vin ordinaire* on the streets of Paris, and a quart bottle of cream as much as a quart of good champagne in Paris. Despite much denial it appears to me that milk is not sold as cheaply as it ought to be. Everything should be done to conserve our herds of cows for the increased supply of whole milk and incidentally for the manufacture of cheese and of milk powder or of condensed milk.

If one takes milk with other foods meat may be dispensed with. Thus Hindhede advocates as ideal a diet consisting of bread, potatoes, fruit and a pint of milk. Splendid health, both of body and mind, the peasants' comparative immunity to indigestion, kidney and liver disease, as well as an absolute immunity to gout, is the alluring prospect held out by the following dietary:

Graham bread	1 lb.
Potatoes	2 lbs.
Vegetable fat	¼ lb.
Apples	1½ lbs.
Milk	1 pint.

This bread-potato-fruit diet gives a very excellent basis of wholesome nutrition. The potatoes yield an alkaline ash which has a highly solvent power over uric acid, and therefore a good supply of these valuable tubers is needed by the nation.

To most Americans the dietary factors here described will appear to be merely attenuated hypotheses, fit only for philosophic contemplation. For, in real life, it is the roast beef of Old England, or some other famed equivalent, that makes its appeal. Far be it from me to disparage the feast following a hunt of the wild boar or other feasts famed in song and story, but that is not the question. The question is, is meat necessary? The description of the Italian dietary answers this in the negative.

But is meat desirable? The Italian experimenters believed that the addition of 4 or 8 ounces of meat to the dietaries of some of their subjects increased their physical and also their mental powers. The increase in mental power due to change in diet has always seemed to me to be a figment of the imagination and not susceptible of demonstration. Thomas lived for 24 days on a diet of starch and cream, during 4 days of which time the very small quantity of 3 ounces of meat was taken daily, and he found his mental and muscular power unchanged.

A remarkable experiment on the effect of a potato diet has been reported by Hindhede. An individual partook of a diet of between 4½ and 9 lbs. of potatoes daily with some vegetable margarine during a period of nearly three hundred days. The rule was to eat only when hungry and then the potatoes could be taken at the rate of an ounce a minute. During the last three months (95 days) of the experiment severe mechanical work was performed and the total food intake for the latter period amounted to 770 lbs. of potatoes and 48 lbs. of margarine. What could be more simple than stocking the cellar with coal,

potatoes and a tub of margarine! Who then would worry about the complexities of modern life?

Of course vegetarianism is no new thing. Its principal exponent was Sylvester Graham. It so happens that he was the brother of my great grandmother, and of him my father wrote in 1861 "long lanky Sylvester Vegetable Graham, leanest of men." Graham in 1829 began the advocacy of moderation in the use of a diet consisting of vegetables, Graham bread, fruits, nuts, salts and pure water, and excluding meat, sauces, salads, tea, coffee, alcohol, pepper and mustard. The first effect of this diet, which largely eliminated the flavors, was to reduce the weight through lowering the intake of food, but the health of many followers of the diet appears to have been benefited. The "Graham System" of dieting suffered from withering criticism at the time. He published in 1837 a little book entitled: "Bread and Bread Making," bearing on its cover the scriptural quotation "Bread strengtheneth man's heart." He says in this volume:

> But while the people of our country are entirely given up as they are at present, to gross and promiscuous feeding on the dead carcasses of animals and to the untiring pursuit of wealth, it is perhaps wholly vain for a single individual to raise his voice on a subject of this kind.

The well-known work of Chittenden has shown that when the protein intake is reduced by one half or less of that which the average American appetite suggests, professional men, soldiers and athletes may be maintained in the best physical condition. One of Yale's champion intercollegiate athletes won all the events of the year in which he was entered while living on a reduced protein or Chittenden diet. Upon such a diet, or less than that, the people of Germany are now living to-day. The principle involves eating meat very sparingly, taking half a piece where one would have formerly been taken, and using it only for its flavor. The wing of a chicken has little meat on it and yet if eaten together with vegetables it gives the meal a different quality than it would have had without it, and to this extent its use is warranted. The muscles are active when hard labor is done, but the muscles do not need meat for the performance of their work. A fasting man may have considerable power. The popular idea of the necessity of meat for a laboring man may be epitomized in the statement: a strong man can eat more meat than a weak one, hence meat makes a man strong. The proposition is evidently absurd.

Indulgence in meat is due to the desire for strong flavor.

With the increased distribution of wealth, the demand for meat grows. Its consumption by all classes had vastly increased in all prosperous countries prior to the war. It is well, however, to remember that its use has been excessive and unnecessary, and its price can be cut by wholesale voluntary abstinence. The British people have suffered no hardship in the recent reduction of their meat ration.

A British Commission has reported to Parliament that it takes three times as much fodder to produce beef as it does to produce milk or pork of the same food value. Since cows eat chiefly hay and grass and pigs eat grain the cost of the production of a unit value of milk is much less than the cost of the same value in the form of pork. It takes only fifty per cent. more fodder to produce veal than to produce pork. Milk, pork and veal have long been the established protein-containing foods of nations on the continent of Europe. According to these figures beef should cost in the market twice what veal costs, and yet the butcher charges nearly the same for the two. It would save food for milk production if steers were eaten as veal and not fed up into beef cattle. If all heifers were developed into milch cows and no cow capable of giving milk in quantity were slaughtered, the country would be placed on a much better basis than at present. It would make beef expensive, but there is every reason why it should be expensive. It would increase the dairy business, which is evidently a need of the times, something for the protection of the welfare of mankind. For it must be remembered that a well-nourished cow during a single year will give in the form of milk as much protein and two and a half times the number of calories as are contained in her own body.

This was written before the publication of the following words of Armsby, the foremost authority on animal nutrition:[2]

> Roast pig, to those who like it, is not only a delicacy but a valuable article of diet, but nevertheless, it is possible to pay too high a price for it, and while a proposal to restrict rather than to promote meat production in the present crisis may appear both irrational and unpatriotic it may nevertheless be in the interest of true food economy. . . .
>
> It may be roughly estimated that about 24 per cent. of the energy of grain is recovered for human consumption in pork, about 18 per cent. in milk and only about 3.5 per cent. in beef and mutton. In other words, the farmer who feeds bread grains to his stock is burning up 75 to 97 per cent. of them in order to produce for us a small residue of roast pig, and so is diminishing the total stock of human food. . . .
>
> The task of the stock feeder must be to utilize through his skill and knowledge the inedible products of the farm and factory such as hay, corn

[2] "Roast Pig," *Science*, 1917, XLVI., 160.

stalks, straw, bran, brewers' and distillers' grains, gluten feed, and the like, and to make at least a fraction of them available for man's use. In so doing he will be really adding to the food supply and will be rendering a great public service. Rather than seek to stimulate live stock husbandry the ideal should be to adjust it to the limits set by the available supply of forage crops and by-product feeding stuffs while, on the other hand, utilizing these to the greatest practicable extent, because in this way we save some of what would otherwise be a total loss. . . .

The hog is the great competitor of man for the higher grades of food and in swine husbandry as ordinarily conducted we are in danger of paying too much for our roast pig. Cattle and sheep, on the other hand, although less efficient as converters, can utilize products which man can not use and save some of their potential value as human food. From this point of view, as well as on account of the importance of milk to infants and invalids, the high economy of food production by the dairy cow deserves careful consideration, although of course the large labor requirement is a counterbalancing factor.

At any rate, it is clear that at the present time enthusiastic but ill-considered "booming" of live stock production may do more harm than good. If it is desirable to restrict or prohibit the production of alcohol from grain or potatoes on the ground that it involves a waste of food value, the same reason calls for restriction of the burning-up of these materials to produce roast pig. This means, of course, a limited meat supply. To some of us this may seem a hardship. Meat, however, is by no means the essential that we have been wont to suppose and partial deprivation of it is not inconsistent with high bodily efficiency. Certainly no patriotic citizen would wish to insist on his customary allowance of roast pig at the cost of the food supply of his brothers in the trenches.

Heat from the sun enters into the composition of the food substances when they are being built up in the plants, and this energy, which is latent in the food, is set free in the animal body and is used as the source of power behind all the physical activities of the body. The energy can all be recovered as heat and measured in the form of calories. According to the principles of the law of the conservation of energy, heat is not destructible. The understanding of the value of a calorie is indispensable for the comprehension of nutrition. A calorie is the measure of a unit of heat, or the quantity of heat necessary to raise a liter of water from 0° to 1° Centigrade. Apparatus has been invented for measuring the heat production of a man, an apparatus which is called a calorimeter or a measurer of calories. If one puts a man weighing, say, 156 pounds in the box of such an apparatus, so that he lies comfortably on a bed in complete muscular relaxation, and before his breakfast, one finds that he produces 70 calories an hour. Only in certain types of disease is there any variation from this normal, though of course the weight of the man makes a difference in his requirement for energy. If, at the same time the subject is in

the box, the quantity of oxygen which he absorbs is measured and if certain other chemical analyses be carried out, one can calculate the exact amounts of protein, fat, and sugar which have been oxidized by this oxygen. Now if one calculates how much heat ought to have been set free from the oxidation of these quantities of protein fat and carbohydrate, it is discovered that the heat which ought to have been produced is exactly that quantity which was measured as having been produced by the man. This measurement represents the *basal metabolism* of a man at complete rest, when his oxidative activities are at their lowest ebb.

The basal metabolism as measured by 70 calories per hour in the case of this individual represents the sum of the fuel needed (1) to maintain the beating of the heart, which every minute of a man's life moves the blood or one twentieth part of the weight of the body, in a circle through the blood vessels; (2) to maintain the muscles of respiration that the blood may be purified in the lungs; (3) to maintain the body temperature at that constant level which is so characteristic that a slight variation signifies illness, and (4) to maintain in the living state the numerous tissues of the body. Any extraneous muscular movements are carried out in virtue of an increased oxidation of materials and the heat production rises above the level of the basal metabolism with increased muscular effort. For a long time the power for the maintenance of the human machine can be furnished by its own body fat, as is seen in cases of prolonged fasting, but usually the power is derived instead from the food-fuel which is taken. The great question in the world to-day is whether or not a sufficient quantity of food-fuel is available to support the human family. The question of calories is not an academic one, but an intensely practical one.

The following values may be cited from the literature on the subject, as showing the daily requirement of energy for working people when the work day is of eight hours. A seamstress sewing with a needle required 1,800 calories. Two seamstresses using a sewing machine required 1,900 and 2,100 calories. Two women book-binders required 1,900 and 2,100 calories. Two household servants employed in such occupations as cleaning windows and floors, scouring knives, forks and spoons, scouring copper and iron pots required 2,300 to 2,900 calories. Two washerwomen, the same servants as last named, required 2,600 to 3,400 calories in fulfilment of their daily work.

Concerning the fuel requirement for the occupations of men: Two tailors required 2,400 and 2,500 calories. A bookbinder required 2,700 and a shoemaker 2,800. Two metal workers filing and hammering metals required 3,100 and 3,200 calories. Two painters occupied in painting furniture required 3,200 and 3,300 calories and two carpenters engaged in making tables required the same amount of energy. Farmers of all nationalities—United States, Mexico, Italy, Finland—required 3,500 calories. Two stonemasons chiseling a tombstone required 4,300 and 4,700. Two men sawing wood needed 5,000 and 5,400 calories.

Other studies upon the requirements of lumbermen engaged in chopping and yarding logs, bicycle riders in six-day bicycle races and men engaged in long mountaineering ascents show that the demand for food-fuel may reach 10,000 calories daily.

It is evident from this analysis that whenever there is physical labor to be accomplished the demand for food-fuel increases. The present world food situation depends not only on a short wheat crop, but also upon the fact of an increased demand for food-fuel on account of an increased speeding up of the human machines, which latter factor includes a largely increased amount of muscular work done by women.

A British scientific commission has reported to Parliament that if the workman be undernourished he may by grit and pluck continue his labor for a certain time, but in the end his work is sure to fail. It makes no difference what the nutritive condition of the person is, if a certain job involving muscular effort is to be done it always requires a definite amount of extra food-fuel to do it. Rubner, the greatest German authority on nutrition, excited grossly inappropriate hilarity in the comic press of his country, by showing that a poor woman who waited several hours in line in order to receive the dole of fat allowed her by the government, actually consumed more of her own body fat in the effort of standing during those hours than she obtained in the fat given her when her turn to receive it came at last.

A method by which food-fuel can readily be saved with benefit to the nation and to the individual is for the over-fat to reduce their weight. This has been done with drastic severity in Germany. I have heard from unquestioned sources how a man who had weighed 240 pounds lost 90 pounds since the war began; how a corpulent professor at Breslau lost greatly in weight, but during the second summer of the war regained

his former corpulence during a sojourn in the Bavarian Tyrol, a joy not now tolerated; and how an American woman lost 40 pounds in weight last winter in Dresden. There is every reason why a man who is over-weight at the age of fifty should reduce his weight until he reaches the weight he was when he was thirty-five. According to Dr. Fiske he is a better insurance risk if after thirty-five he is under the weight which is the average for those of his years. Reduction in weight reduces the basal requirement for food, and reduces the amount of fuel needed for moving the body in walking. The most extreme illustration of the effect of emaciation upon the food requirement is afforded by a woman who after losing nearly half of her body weight was found to need only 40 per cent. of the food-fuel formerly required. This represented a state not far from the border line of death from starvation, but it indicates how a community may long support itself on restricted rations. It must be strictly borne in mind however that if any external muscular work is to be accomplished it can only be effected at the expense of a given added quantity of food-fuel, whether the person be fat or thin.

It is not at all difficult to reduce the body weight. Suppose a clergyman or a physician requires 2,500 calories daily in the accomplishment of his work and takes 2,580 calories per day instead. The additional 80 calories is the equivalent of a butter ball weighing a third of an ounce, or an ounce of bread or half a glass of milk. It would seem to be the height of absurdity to object to such a trifle. But if this excess in food intake be continued for a year the person will gain nine pounds and at the end of ten years ninety pounds. Such a person would find that he required a constantly increasing amount of food in order to transport his constantly increasing weight. In instances of this sort a motto may be applied which I heard the last time I was in Washington: "Do not stuff your husband, husband your stuff."

Now it is evident that, if instead of taking more than the required amount of food a little less be taken than is needed the balance of food-fuel must be obtained from the reserves of the body's own supply of fat. By cutting down the quantity of fat taken, or by eliminating a glass of beer or a drink of whiskey, and not compensating for the loss of these by adding other food stuffs, the weight may be gradually reduced. The amusing little book entitled "Eat and Grow Thin" recommends a high protein and almost carbohydrate-free diet for the accomplishment of this purpose, but its advice has made so many of

my friends so utterly miserable that I am sure that in the end it will counteract its own message.

The work of the world is accomplished in largest part by the oxidation of carbohydrates, that is to say of sugars and starches. Bread, corn, rice, macaroni, cane-sugar, these are *par excellence* the food-fuels of the human machine. They are all convertible into glucose in the body, which glucose gives power to the human machine. Fat may be used for the same purpose, but unless carbohydrate is also present a person can not work up to his fullest capacity.

As all the world is seeking for food-fuel with which to do work, I want to place before you a plea that the public be informed as regards the energy value of its purchases. It is but repetition of an already published statement.[3]

A barrel of flour weighs 196 pounds. One pound of flour yields 1,650 calories. One barrel of flour, therefore, contains 1,650 times 196, or 323,400, calories. The farmer in 1916 received $1.50 a bushel for his wheat, which would make the barrel of flour cost about $7.50. In February, 1917, the cost was $9 a barrel, whereas in May of the same year it sold at retail at $17 and more a barrel and in August the price had fallen slightly. These costs may thus be reckoned:

	Price Per Barrel of 323,400 Calories	Price Per 1,000 Calories
Flour, based on 1916 price of wheat paid to farmer	$7.50	$0.023
Flour, February, 1917	9.00	0.028
Flour at retail in New York, May 22, 1917	17.12	0.053
August 27, 1917	15.29	0.048

Since one third of the food-fuel of America, England, and France is derived from flour, it is evident that the extortionate price exacted for bread, which has been called the staff of life, puts a severe load upon the human family and has placed under fire the modern machinery of food speculation which has made such prices possible.

Passing now to a consideration of the foods sold in packages, I bought at a department store on May 22 the following foods, at the following cost per thousand calories:

	Price per 1,000 Calories
Cornmeal	3⅓ cents
Karo Corn Syrup	5½ cents
Wheatena	8 cents
Grape-Nuts	8½ cents

[3] *World's Work*, August, 1917.

Sunshine Cheese Wafers	15 cents
Quaker Oats	4½ cents
Cream of Wheat	5¾ cents
Corn Flakes	8¼ cents
Animal Crackers	11½ cents
Nabisco Wafers	32 cents
Imperial Cheese	41 cents

I firmly believe that a great advance would be scored if the value in calories were placed on every food package sold.

As to the use of alcoholic beverages the question resolves itself into several factors. Alcohol gives a sham sensation of added force and in reality decreases the ability to do work. Alcohol is the greatest cause of misery in the world and as Cushny has put it, if alcohol had been a new synthetic drug introduced from Germany, its importation would long since have been forbidden. On the other hand good beer makes poor food taste well. It also frequently leads to overeating. The cure for bad food is to have our daughters taught how to cook a decent meal. After that we can talk about prohibition.

The food situation is probably more serious than most of us realize. The country should be stirred to a keener sense of its responsibilities. In conclusion, let us agree if we can to the following propositions:

1. Eat corn bread and save the wheat for France, the home of Lafayette, and for our other allies.

2. Let no family (of five persons) buy meat until it has bought three quarts of milk.

3. Save the cream and butter and eat vegetable oils and oleomargarine.

4. Eat meat sparingly, rich and poor, laborer and indolent alike.

5. If fat, grow thin.

6. Be a prohibitionist for the period of the war (if you have enough resolution).

7. Save everything that can be used for food, because food is precious.

8. Finally remember that all the world is seeking for food-fuel with which to do work and that, though our wheat crop is short, still we are the nation most richly endowed with food-fuel. It remains to be seen whether we have the intelligence to fitly utilize for the welfare of mankind the resources which God and nature have placed in our hands.

SPECIFIC PREVENTIVE AND CURATIVE THERAPY, WITH SPECIAL REFERENCE TO GASEOUS GANGRENE

By IDA W. PRITCHETT

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THERE are two kinds of immunity—natural and acquired. Natural immunity to certain diseases is sometimes the common property of a whole species of animal, as in the case of the immunity of fowls to tetanus infection. Immunity may be acquired either through an attack of the disease, in which it may persist for a lifetime, or through protective inoculation with the bacterial bodies or their products. In the case of vaccination with the killed or attenuated bacterial bodies an active immunity is set up in the person vaccinated, his own body cells reacting in such a way to the bacteria introduced that actively immune substances, antagonistic to the specific bacteria injected, are produced within his body and exist in considerable quantities in his blood stream. Such an immunity, while not nearly so enduring as that acquired from an attack of the disease, may last for several years, and such a person, although he has never had the disease in question, is said to be actively immune to it.

Immunity may also be conferred upon one individual by injecting into his blood stream large quantities of the serum of another individual actively immunized to the disease. Such an immunity is said to be passive, because the body cells of the person inoculated take no part in it, the degree of immunity depending wholly upon the concentration of immune substances, or "antibodies," in the serum injected. Immunity of this sort is, of course, very fleeting in character. It can be maintained only by repeated injections of the immune serum and is applied as a precautionary measure where there is a possibility of infection, as in tetanus, or as a curative agent in an acute disease like diphtheria.

Immune sera for therapeutic use are usually produced in horses. Such sera may be of two kinds. They may be produced with the bacterial bodies themselves, in which case they are called antibacterial sera; or they may be produced with

sterile filtrates containing the soluble toxic products of the bacteria, when they are known as antitoxic sera, or antitoxins. An antibacterial serum acts directly upon the specific invading microorganism and prepares it for destruction by the body cells, while an antitoxic serum, by neutralizing the toxin produced by the bacteria during growth, inhibits that growth and prevents its spread, thus giving the body a chance to destroy the bacteria. An example of an effective antibacterial serum is that used in the treatment of cerebrospinal meningitis. The meningococcus, which is the specific organism against which this serum is prepared, does not secrete in cultures a true bacterial toxin, but there can be prepared in horses, by the injection of the bacterial bodies, a potent serum which has proved extremely valuable in the treatment of this disease.

An example of an antitoxic serum is that prepared against diphtheria. Such a serum is produced in horses by the injection of the sterile filtrate from broth cultures of the diphtheria bacillus. This organism secretes, when grown in a suitable medium, a true soluble toxin which may be filtered through the finest filters and still prove fatal for guinea pigs in very small doses, after all the bacteria have been removed. It is only with a true secretory toxin like this that an antitoxic serum can be produced. The bacterial toxins so far shown to be of large practical importance are those of diphtheria and tetanus, and the sera prepared with these toxins are the only true antitoxins at present in general use. Certain antibacterial sera, notably that prepared with the Shiga dysentery bacillus, possess a degree of antitoxic power in addition to their antimicrobial properties, but it is insufficient to warrant their being classed with the true antitoxins.

The terms "vaccine" and "serum" are often confused, even used synonymously by laymen and physicians as well. They are very different in their biologic natures and fields of usefulness. It is considered expedient, therefore, to state here briefly the difference between a "vaccine" and a "serum." A vaccine, strictly speaking, is a suspension of the killed or attenuated bacterial bodies in some sterile fluid such as physiological salt solution. In the case of a disease like smallpox, where no visible bacterial agent can be demonstrated, the vaccine is made from the attenuated "virus," which is the living infectious agent. A serum, on the other hand, is the clear yellowish residual fluid remaining after blood has been allowed to clot and all the corpuscles and the fibrin have separated out. It contains none of the bacteria or toxin with which it may have

been rendered immune in the living animal body, but only those reaction products of the animal to the bacteria or toxin injected that make it a fit therapeutic agent for use against the organism that produced it. It differs from a vaccine in containing the reaction products of the animal to the bacteria or their toxins rather than the bacterial bodies themselves. The most widely and successfully employed vaccines are those prepared against smallpox, rabies, typhoid and paratyphoid fever. Their injection incites a reaction on the part of the body cells of the inoculated person and thereby confers an active immunity which is capable of warding off infection for a period of two or more years. Immune sera, such as diphtheria and tetanus antitoxins, confer, on the other hand, a passive immunity which lasts only about two weeks. Vaccines find their greatest usefulness as preventive agents, while antitoxins are of great value as both curative and preventive agents. Tetanus antitoxin is very widely used to prevent lockjaw after certain predisposing injuries; it possesses healing power also. Diphtheria antitoxin may be used to ward off the disease after known exposure to infection, but it is especially efficacious as a curative agent.

The organism with which the present article[1] is mainly concerned is known as *Bacillus welchii*. It was first described in 1892 by Welch and Nuttall, who found it in a human case at autopsy and gave to it the name of *Bacillus aerogenes capsulatus* —the "gas-forming capsulated bacillus." Since then the organism has been described in human infections by men of various nationalities and has been given a different name by almost every investigator. In the United States it is known as *Bacillus welchii*; in France as *Bacillus perfringens*; in Germany as *Bacillus phlegmonis emphysematosae*, and an English investigator named it *Bacillus enteritidis sporogenes*. These are only a few of the names that have been given this same organism by the different men who have worked with it. The confusion arising from these variations is obvious.

Morphologically *Bacillus welchii* is a large, plump rod, with the ends very slightly rounded. It occurs singly or in pairs, and in infected tissues is often found in long chains or filaments. Both in artificial cultures and in infected tissue it forms large amounts of gas and acids. The gas is chiefly hydrogen and carbon dioxide. The acids are a mixture of organic acids, chiefly butyric. Both acids and gas are formed very readily in

[1] A fuller and more technical treatment is given in the paper by Bull, C. G., and Pritchett, Ida W., entitled "Toxin and Antitoxin of and Protective Inoculation Against *Bacillus welchii*" and published in the *Journal of Experimental Medicine*, 1917, XXVI., 119.

beef infusion broth, to which glucose has been added, the acidity increasing with the amount of glucose. A 3 per cent. glucose broth culture sometimes becomes 7 per cent. acid in three or four days. Growth in milk, to which litmus has been added, presents a characteristic appearance. The blue litmus milk first becomes pink, due to the formation of acids. Then the curd forms and is bleached, and finally the gas given off blows the curd to pieces, and all the whey is expressed. In such a culture we have manifestations of two of the chief characteristics of *Bacillus welchii*, namely the formation of acid and of gas.

This organism does not develop unless the oxygen has been at least partly removed from the medium in which it is grown, either by boiling or by exhaustion in a vacuum jar. It is therefore classed among the bacteria known as anaerobic, although it is not as strictly anaerobic as the tetanus bacillus or the virus of poliomyelitis. It is very widespread in nature, existing normally in the intestinal tracts of man and animals, in most samples of market milk, in dust, in wool, on the skin—in fact, almost everywhere, It is able to maintain itself under unfavorable circumstances and to grow again when the proper conditions are provided through its ability to form spores. These spores are highly resistant to influences that are fatal to the ordinary growing or vegetative form of the organism. They can stand without serious injury a degree of heat that kills all the vegetative forms. They require no nourishment and may remain alive and virulent for a very long time. This ability to form spores is the common property of a great many bacteria, of which fortunately only a few—tetanus, anthrax, malignant edema, *Bacillus welchii*, and possibly others—are pathogenic for man.

With an organism as widely distributed as *Bacillus welchii*, infection may easily occur. It has been cited as the cause of pathological conditions as unrelated as diarrhœa and inflammation of joints, but it is primarily an invader of muscular tissue, rarely gaining access to the general circulation during life. Furthermore, the muscular tissue must be lacerated and the wound deep to provide the most ideal conditions for its growth. Healthy muscle is usually attacked only after the bacteria have invaded an adjacent crushed and torn area. When infection is once established in such a crushed muscle, it spreads very rapidly. Large amounts of gas are formed, distending the tissues and escaping in bubbles into the open wound. There is an escape of fluid from the vessels into the infected tissues, producing what is known as an edematous

condition. The tissues in and around the wound are so injured by the growth of the bacteria that they die and become gangrenous. If nothing is done to check its progress, the infection spreads rapidly, gas becomes evident in tissues far removed from the primary focus of infection, death of the muscles and gangrene progress rapidly, and collapse and death soon follow. This is the condition produced by *Bacillus welchii* in lacerated muscular tissue and, on account of the large amount of gas formed in the necrotic muscles, is known as gaseous gangrene.

The incidence of gaseous gangrene in civil life is not high. A certain number of cases is always to be found in city hospitals, due largely to industrial injuries and street accidents, but they form a very small percentage of the total yearly hospital records. Under war conditions, however, gaseous gangrene becomes a very different problem. A very large number of the wounds received on the battlefields of Europe are infected with the gas bacillus. The country through which the armies are fighting has been intensively cultivated for centuries, and the rich earth is necessarily heavily infected with all manner of intestinal bacteria, the spores of tetanus and gas bacillus among them. Under the conditions of trench life the soldiers' uniforms become caked with this infected earth, and when shell wounds occur, a bit of cloth is usually carried deep into the lacerated tissue, and ideal conditions are produced for the development of tetanus or of gaseous gangrene. The tetanus problem is well solved by the administration of a prophylactic dose of tetanus antitoxin to every wounded man at the first dressing station, to guard against a possible infection. By this means the incidence of tetanus, once so appalling, has been reduced to relatively few cases, but the tetanus antitoxin has no effect upon the development of gaseous gangrene, being specific for tetanus. The wounded must therefore take their chances of gas infection with all its awful consequences which the vastly improved methods of antisepsis and wound irrigation have not yet entirely abolished. There is every reason to believe, however, that the antitoxin whose discovery at the Rockefeller Institute was recently announced by Bull and Pritchett will be as effective in preventing gaseous gangrene as tetanus antitoxin is in preventing lockjaw, and also that it will exhibit curative properties.

The theories of the manner of the destructive action of *Bacillus welchii* in the infected animal body are almost as varied as its names. Some attribute its injurious effect to the absorption of toxic decomposition products from the infected

and disintegrating tissues. Others consider that the harmful effects are due to the large quantity of gas formed, which, being unable to escape, collects in the tissues, gradually cuts off the blood supply by the pressure it exerts and so causes death of the tissues; this dead tissue is then invaded by putrefactive bacteria which disorganize it, and so gaseous gangrene is established. Still others have maintained that the pathological condition is due to the irritating effect of the large amount of acids formed in the tissues and have claimed to be able to reproduce in animals identical lesions and death by injections of the pure organic acids. These are only a few of the theories that have been advanced to account for the pathology of gas infection. It remains to present the theory of the toxic action of the bacilli.

In undertaking a study of gaseous gangrene, one is struck by the fact that the infection, though essentially a local one, *i. e.*, confined to a more or less circumscribed area and rarely, if ever, gaining entrance to the blood stream, is yet capable of causing extreme prostration and death, sometimes within a very few hours after the appearance of the first symptoms. This leads one to compare it with other infections, such as tetanus and diphtheria, which are also purely local in character, and in each of which the active agent is known to be a very powerful toxin, secreted by the bacteria during the process of growth and disseminated through the body by means of the circulating blood. Although neither tetanus nor diphtheria presents the extensive destruction of tissues that we find in gas infection, the other points of similarity make it reasonable to suppose that like them *Bacillus welchii* might secrete a true soluble toxin which is its chief weapon of offense, and without which it would be powerless to cause the lesions typical of gaseous gangrene. This supposition led to an effort to reproduce in the test tube the ideal conditions for growth that we find in deep, lacerated wounds of the muscular tissues—namely, absence of oxygen and a supply of raw muscle.[2] To this end a 0.2 per cent. glucose beef infusion broth was made up, glucose being the chief muscle sugar and especially favorable for the growth of the gas bacillus. To tubes containing ten cubic centimeters of this sterile broth were added fragments of fresh sterile rabbit or pigeon muscle. These tubes are inoculated with a pure culture of *Bacillus welchii* and after being incubated over night at 37° Centigrade are filtered through sterile filters. The clear amber filtrate thus obtained contains the soluble toxic products of the gas bacillus. Such a filtrate is capable of causing, in very small doses, the

[2] Bull, C. G., and Pritchett, Ida W., *loc. cit.*

typical picture of gaseous gangrene—edema of the tissues, extensive necrosis of the muscles, and death. Its pathological effects can be differentiated from the infection itself only by the absence of bacteria and of gas. Like all true toxins, it does not immediately produce its effect, but requires a latent or an incubation period. Its toxic action is not affected by neutralization with sodium hydroxide, a fact which rules out the acid as the principal cause of the lesions. It conforms in every way to the requirements of a true secretory toxin similar to those of tetanus and diphtheria. Finally it has been possible to produce with it a potent antitoxic serum which will not only neutralize the toxin so that it produces no lesion, but will inhibit the growth of the bacteria in the body. It has been possible to treat successfully well established infections, so that the lesions healed completely. And most important of all, complete immunity of at least two weeks' duration against both the toxin and the live bacteria can be conferred upon guinea pigs and pigeons by injecting them subcutaneously with a small amount of antitoxin. The animals so treated are entirely refractory, during this period, to subsequent injections of toxin and of live culture that kill normal guinea pigs in a very short time. These facts point to the possibility of a serum prophylaxis for gas gangrene as effective as that already used in the prevention of tetanus.

Rabbits, goats, and horses have all been made to yield antitoxic sera by injecting them subcutaneously or intravenously with carefully graded doses of toxin. At present several horses and goats are in process of immunization. These animals are injected at regular intervals and are bled from time to time to test the amount of antitoxin present in their sera. These antitoxins are carefully standardized, the number of antitoxic units in a cubic centimeter of serum being determined for each bleeding. In this way a record is kept of the increase in antitoxic power of the serum of each animal.

It would appear, then, that there is every reason to look to the serum treatment for a profound decrease in the incidence of and fatalities from gaseous gangrene due to war wounds. The ideal condition would be to give a prophylactic or preventive dose of the antitoxin to all wounded men at the first dressing station as is now done with tetanus antitoxin. In this way it is fair to hope that the development of gaseous gangrene may be prevented in many or almost all cases, besides which the antitoxin appears to be of distinct value as a curative agent in cases of gaseous gangrene already developed.

IS AN INFORMAL PEACE CONFERENCE NOW POSSIBLE?

By CHARLES W. ELIOT

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THE urgent international problem to-day is how to bring about a frank and sincere conference of the belligerent nations without an armistice—since neither group would now take the obvious risks of an armistice—a conference consultative and not arbitral, and only preliminary to the official conference of governments which must devise and propose a real settlement. This problem is difficult, but not insoluble.

After three years of warfare, strenuous and continuous beyond all precedent, the military situation to-day is described fairly well by the word stalemate. For each party it is inconclusive; and there is no umpire. Either party can hold the other in trench warfare. The Entente Allies can drive the Germans back for short distances; but neither side has as yet won a decisive victory in trench warfare, or captured an army in open country. Because of the superiority of the Entente Allies and the United States in number of men, industrial productiveness and financial strength, Germany in all probability can be brought to a condition of exhaustion before the Allies will be; but this result can be brought about only by prolonged and desperate sacrifices of human life and of the savings of the nations, and at the cost of infinite human woe.

Although all the nations involved are longing for peace, their governments are in no condition to discuss terms of peace. The political and industrial changes brought about by the war are tremendous; but they are manifestly incomplete. Democracies have been obliged to change many of their habitual modes of action; autocracies are facing internal agitations; one autocracy has just disappeared, but no stable government has as yet taken its place; many industries have to be carried on under new conditions as regards both labor and capital; and war itself is conducted in new ways which disregard the ethics heretofore thought to be universally accepted. There is a general wondering as to what is going to happen next, which indisposes responsible persons to large committals, or decisions

which can not be recalled. The Entente Allies do not state clearly their minimum demands or lowest terms for peace, and the Central Monarchies state no terms at all.

Under such circumstances it is wholly natural for combative and indignant men and women to say, "What is the use of talking with the German rulers about terms of peace; they will not keep their word, if they can obtain any military advantage by breaking it? We must fight till we are plainly victorious." On the other hand, the various official and unofficial statements of the terms on which the Allies would be willing to make peace produce on the German mind, so far as their opponents can discover, only this effect—"We are fighting a war of defense against dismemberment or imprisonment; we must fight to the last gasp in the hope that some favoring chance or discord among our enemies may save us from the threatened destruction." This is indeed a horrible dilemma; and many righteous men say that there is no way to escape from it, except by the overpowering of one or other of the combatants. Before settling down, however, to this long struggle, is it not worth while to try a limited preliminary experiment on human capacity for good feeling and sound reasoning even under the most adverse circumstances?

Even under the actual very discouraging circumstances, he would be a bold man who should affirm that it is impossible to bring appointed conferees from all the belligerent nations into one room for the oral discussion of subjects previously agreed upon, the conferees being selected by the several governments, but receiving no instructions either before or during the conference from the appointing powers, and having no power or commission except to make a brief, public report of their conclusions. The function of the several governments would be limited to the appointment of the conferees and the granting of the necessary safe-conducts. In order to keep the size of the conference moderate, each small state might be restricted to two conferees, and each large state to four.

The two principal subjects of discussion ought to be:

I. The means of so organizing the civilized world that international war can be prevented—by force, when peaceable means have failed.

II. The removal or remedying in good measure of the public wrongs, injustices and distrusts which contributed to the outbreak of the present war, or have been created during its course —wrong-doings and passions which will cause future wars unless done away with.

There follows a list of the subjects which might well be discussed under each of these two principal heads, the conference itself making choice among them.

Under I:

(*a*) Will the nations concerned publicly recognize as a settled principle of international action, that no nation shall henceforth attempt to exercise rule or domination over any other nation, large or small, occidental or oriental?

(*b*) Can the boundaries of the European states be so readjusted that no European population shall be held by force to an unnatural allegiance contrary to their wishes?

(*c*) Shall the freedom of the seas and of the canals and channels connecting great seas be placed under international guarantees for peace times but not for war times?

(*d*) Will all the nations agree that enlargements of national territory, extensions of national trade, and concerted migrations shall hereafter be brought about only by the consent and with the good-will of all parties concerned, and shall be maintained only by the parties' sense of mutual service and advantage? For expansion of trade, the universal reliance shall hereafter be the policy of the "open door"; and for relief from congestion of population, the policy of "peaceful penetration." Enlargements of territory by purchase or other voluntary contract shall be subject to the approval of the International Council. (See below.)

(*e*) Will the present belligerents agree to form an offensive and defensive alliance for the purpose of instituting and maintaining an international council composed of one delegate from each nation, and an executive commission composed of one commissioner from each of either three or five great powers—such, for example, as Great Britain, France, Russia, Germany and the United States, or the United States, France and Germany, the chairman of the commission to be in either case an American—and an international army and international navy, the function of all these bodies combined to be to prevent international war, if need be by the use of force, and therefore to see that forces adequate to that end are maintained on call, these forces to be decidedly superior to the existing armies and navies of any two nations combined? Other nations might later be admitted to that alliance by the joint action of the international council and the international executive commission, provided that their forms of government might properly be called constitutional or free, and that they were prepared to make some

substantial contribution to the effective forces of the alliance; but no such addition to the first group of nations should be made until at least five years had elapsed from the conclusion of peace.

(*f*) Will the nations agree that as soon as the international army and navy have been put into working order a gradual systematic reduction of armaments shall be made under the direction of the international council and executive commission, so soon as experience has demonstrated the safe limits of reduction?

(*g*) Will all the existing governments agree, in the interest of permanent peace, that for the future the power to declare war and to maintain war by taxation and borrowings shall reside in an elective assembly under conditions which give to the mass of the people, or their elected representatives, control over all questions of war or peace?

(*h*) Will all the nations agree to the suppression of secret diplomacy except as preliminary or tentative inter-communication; so that no treaty, understanding or international arrangement should take any effect until publicly discussed and approved in representative assemblies of the nations concerned?

(*i*) Inasmuch as the present war and many previous wars have been promoted and prolonged because of the existence in most nations of a permanent military class having no other occupation than war and preparation for war, will the belligerent nations now agree to abolish within a reasonable time, each by appropriate legislative and executive action, its "regular" or professional military class, and to substitute for its present military establishment an unpaid democratic army, analogous to the Swiss, based on universal training and liability to service? The Swiss army is here taken as an example because the military constitution of Switzerland has produced an extraordinarily effective army without creating a military class or a militaristic spirit in the Swiss people. Those nations in the alliance which maintain a navy would be expected to cause the navy to be manned on the same principles of universal training and liability to service; but the proportion of officers permanently employed may be larger in a navy than in an army because a larger proportion of a navy than of an army will be constantly on active service.

(*j*) Will the belligerent nations now consent to attempt to secure for the world through the measures indicated above, complete freedom from military or naval aggression?

(*k*) Will the nations represented in the new alliance agree that the expenses of the international council and executive commission shall be borne by each of the allied nations in proportion to its population, and that each nation shall pay the expenses of its quota in the international army and international navy?

(*l*) Will the belligerent nations now agree that another conference at The Hague shall be called soon after the close of the war to consider and recommend for adoption by the several nations a new body of international agreements concerning the conduct of war, to include the new arrangements necessitated by the use, not yet fully developed, of the high explosives, the submarine, and the airplane, and to include also the establishment of an international court with a suitable code of procedure, and of an international council of inquiry and conciliation to take cognizance of incipient international contentions?

Under II:

(*a*) The partition of Poland.

(*b*) The cutting off of Alsace-Lorraine from France in 1870–71.

(*c*) The failure to give Italy in 1866 certain territories long subject to Austria, but unquestionably belonging to the Italian nationality.

(*d*) The discords and enmities introduced into the Near East, and particularly into the Balkan states by the unjust treaties of 1878 and 1913, made under the oversight of the principal European powers.

(*e*) The destruction wrought by the German and Austrian occupation of Belgium and northern France, Poland and Serbia, and the Russian invasion of East Prussia; and the various means of restoring those countries, such as indemnities, repayment of fines and requisitions, and loans from any nations that are able and willing to make them at no interest for a time and a slowly rising rate up to a maximum of five per cent.

(*f*) The oppression of several distinct nationalities which have long been miserable under the control of Turkey.

The status of the German colonies lost during the present war would be another appropriate subject for consideration by the conference. The conference might also consider whether permanent international peace and a just constitution of the international council could be promoted by the application of the principle of federation to some groups of nationalities to

which that principle is not now applied, as for instance to the Scandinavian kingdoms as one group and the Balkan states as another.

It would certainly facilitate the proceedings of an international conference in the interest of durable international peace if it could be understood beforehand that all the participating nations had come to the conclusion that war on the modern scale, and with the new implements of destruction, is not an available means, in the present state of the civilized world, of settling international disputes or of extending national influence and power.

What democracy by its elected executive, or what autocrat can set this experiment on foot? Switzerland would seem an appropriate state to start the experiment, and provide the meeting-room.

A BOTANICAL TRIP TO THE HAWAIIAN ISLANDS

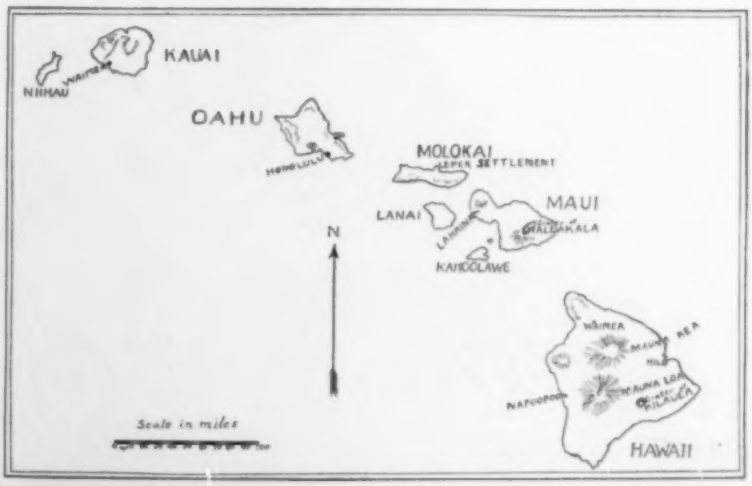
By Professor A. S. HITCHCOCK

U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

DURING the past year I visited the Hawaiian Islands for the purpose of studying their flora, more especially the grasses. Accompanied by my son, Albert E. Hitchcock, as assistant, I spent about five months on the islands, leaving in November. I will give a short account of the country, emphasizing the features that I think will be of interest to botanists, my choice of these features being based upon my own impressions.

A brief account of the geography, topography and climate will not be out of place because, though these data may be obtained from the usual sources, they are unfamiliar to nearly all botanists who have not visited the islands.

The group consists of several large inhabited islands and many small uninhabited islands. The latter, mostly reefs and rocks, lie far to the northwestward of the main group. Among these are Bird Island and Midway Island. The main group consists of eight islands. These in the order of their size from the largest to the smallest are:



THE HAWAIIAN ISLANDS.

FIG. 1. A HAWAIIAN POUNDING THE TARO (*Calocasia esculenta*) TO MAKE POI, a starchy food much used by the natives.

Hawaii	4,015	square miles
Maui	728	square miles
Oahu	598	square miles
Kauai	547	square miles
Molokai	261	square miles
Lanai	97	square miles
Niihau	97	square miles
Kahoolawe	69	square miles

The islands are the most isolated on the globe. An idea of the vast expanse of surrounding ocean may be obtained from the table of distances from the nearest land in various directions.

To San Francisco	2,100 miles
To Tahiti	2,389 miles
To Samoa	2,263 miles
To Fiji	2,736 miles
To Yokohama	3,445 miles
To Sitka	2,395 miles
To Unalaska	2,016 miles

On account of this isolation the indigenous flora of the islands is comparatively meager, but contains a large proportion of

endemic genera and species. All the islands of the group were visited except the two smallest, Niihau and Kahoolawe. The latter is barren and windswept, and at present uninhabited.

The group lies just within the tropics in about the latitude of Cuba, but because of the vast expanse of water the climate, though technically tropical, does not have the high temperature generally associated in the layman's mind with the tropics. The daily maximum temperature in summer at Honolulu is about 85°, the minimum about 75°. The winter temperatures are a few degrees lower.

All the islands are of volcanic origin and are very mountainous. The mountains intercept the northeast trade wind with the result that the eastern sides of the islands have a heavy rainfall while the western sides are dry or even arid. The rainfall on the east or north slopes of the mountains may be from 100 to 300 inches, or on Waialele (Kauai) as much as 600 inches per annum. On the other hand, the annual rainfall is below 15 inches on the southwestern sides of some of the islands.

The sugar industry is the most important and represents the investment of a large amount of capital. Sugar cane is grown on the four large islands on all the low lands where irrigation water is available. In spite of the heavy rainfall most of the plantations supplement this by irrigation, bringing the water from the mountains by means of ditches or aqueducts.

FIG. 2. AN OUTRIGGER CANOE AT WAIKIKI BEACH. The common form of native canoe.

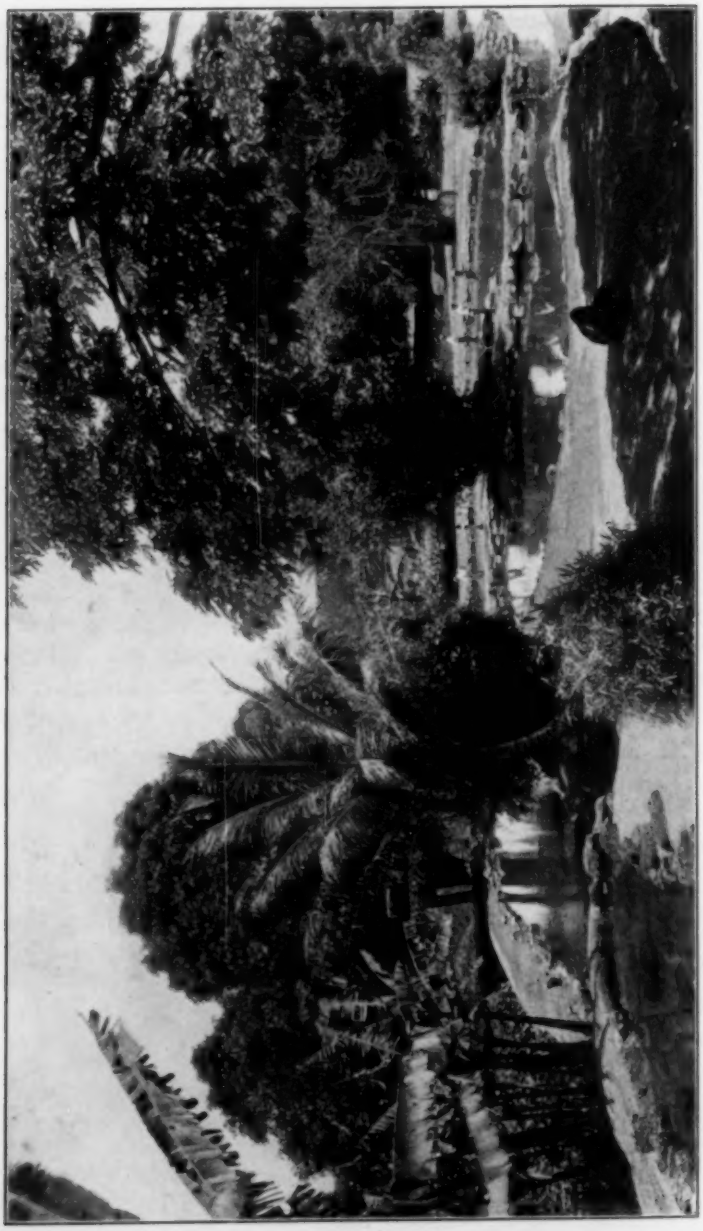


FIG. 3. VIEW IN MOANALUA PARK, HONOLULU.

Most of the sugar mills produce raw sugar, only one producing refined sugar.

The second important industry is stock raising. There are many large ranches devoted to the raising of cattle and sheep. The ranches occupy the land which is too dry for the successful growth of sugar cane. The island of Lanai is practically all one large ranch. The Parker Ranch upon Hawaii is said to embrace over 700,000 acres.

FIG. 4. THE MUNICIPAL BUILDING, HONOLULU, showing the gilded statue of Kamehameha in front. The tall palms are royal palms. At the left is an Araucaria.

The third industry is the growing of pineapples. In comparison with these three, the other agricultural industries are scarcely worth considering. Considerable rice is raised, mostly for local consumption, and there are a few coffee plantations in western Hawaii.

The native inhabitants of the islands, the original Hawaiian race, are fast disappearing, although there are a fairly large number of part-Hawaiians. The present population consists of Americans, Japanese, Chinese, Portuguese, Hindus, Koreans, Filipinos, negroes, and a scattering of other races or nationalities. At present the Japanese predominate. The staple vegetable food of the natives is poi, a product of the root of the taro plant (*Calocasia esculenta*). The starchy root is cooked and then pounded into a pasty mass (Fig. 1). The grass huts of the natives, now to be seen only in less frequented parts of the islands, consist of a framework of wood to which is attached

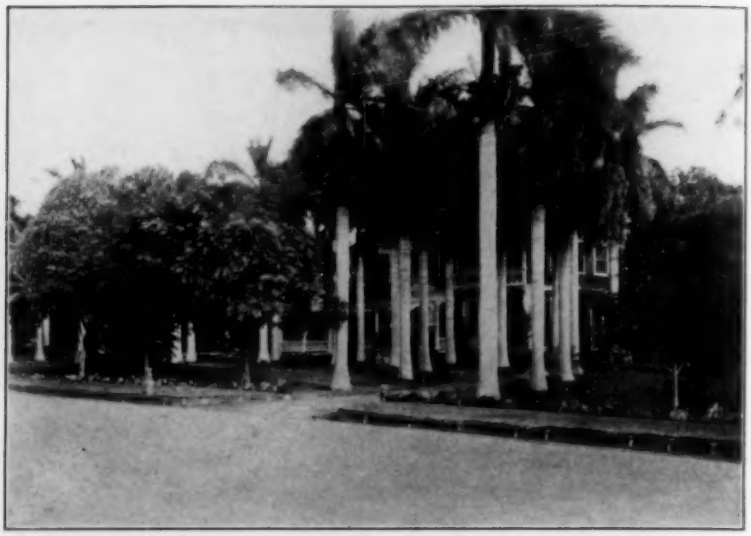


FIG. 5. A RESIDENCE IN HONOLULU WITH AN AVENUE OF ROYAL PALMS.

layers of pili grass (*Heteropogon contortus*), a common native grass on dry or rocky ground.

There are good roads on all the larger islands and travel in the inhabited portions is easy. The higher mountains are reached only by trails and are not easily accessible. Inter-island steamers facilitate travel from one island to another. One line leaves Honolulu in the forenoon and arrives at Hilo on Hawaii the next morning, stopping at Lahaina, island of Maui, on the way. Another line leaves Honolulu in the afternoon and arrives at Waimea, island of Kauai, the next morning. At

FIG. 6. MONKEY-POD (*Samanea Saman*), MOANALUA PARK. A beautiful round-topped tree frequently grown in parks. The grass in the foreground is Bermuda or manienie.

Lahaina one connects with steamers for Molokai and Lanai. There are other steamers that visit outlying points at varying intervals.

As the present article is not intended to be statistical, but

FIG. 7. A BANYAN TREE. The air roots around the trunk have become much condensed by trimming.

rather to give a record of personal impressions, the islands will be discussed in the order in which they were visited.

OAHU

Honolulu is the capital of the territory and is the only large city upon the islands. This is situated on the southwestern side of the island of Oahu, the locality being determined by the presence of a good harbor. The transpacific steamers drop

their passengers here, hence Oahu is the first island of the group to receive the attention of the traveler. Honolulu itself is a handsome city and altogether is the most delightful place it has been the writer's privilege to visit. Back of the city is

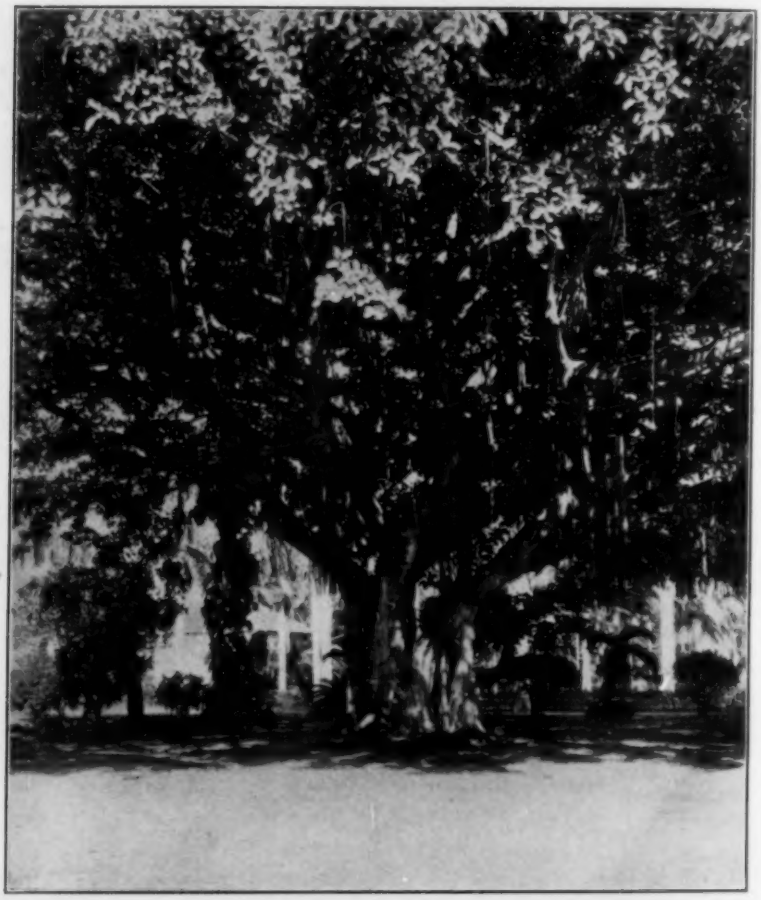


FIG. 8. A BANYAN TREE, showing numerous air roots hanging from the branches.

the Koolau range of mountains with many beautiful valleys lying between the steep ridges that reach down toward the shore at right angles to the main ridge. Honolulu occupies the plain along the coast and extends up into these valleys. A short distance beyond the limits of the city to the south is Diamond Head, a conspicuous promontory that dominates the landscape as one approaches by steamer. It is an old crater now occupied by fortifications. Between here and the city is the famous Waikiki Beach where the bathers throng and where one may see the celebrated surf riders and the outrigger canoes

FIG. 9. A FAMOUS HEDGE OF NIGHT-BLOOMING CEREUS AT PUNAHOU COLLEGE.

(Fig. 2). Another crater known as Punchbowl lies just back of the center of the city.

The visiting botanist is greatly impressed with the beautiful exotic plants in the gardens and parks and along the streets (Figs. 3, 4). The palms are conspicuous, among them being the royal (Fig. 5), the coconut and the date. Two common street

FIG. 10. NIGHT-BLOOMING CEREUS, a few flowers.

FIG. 11. VIEW IN THE HILLEBRAND GARDEN. This garden was formerly owned by Dr. Hillebrand, the author of the "Flora of the Hawaiian Island." It contains a great variety of exotic plants.

trees with strikingly beautiful flowers are the pink shower (*Cassia nodosa*) and golden shower (*Cassia fistula*). The latter has long, cylindrical, woody pods that look like a musician's baton. The hibiscus is much used as a hedge plant, there being scores of varieties, involving several species. The saman tree (*Samanea Saman; Pithecolobium Saman*) is a beautiful, symmetrical, roundtopped tree much grown in parks (Fig. 6).

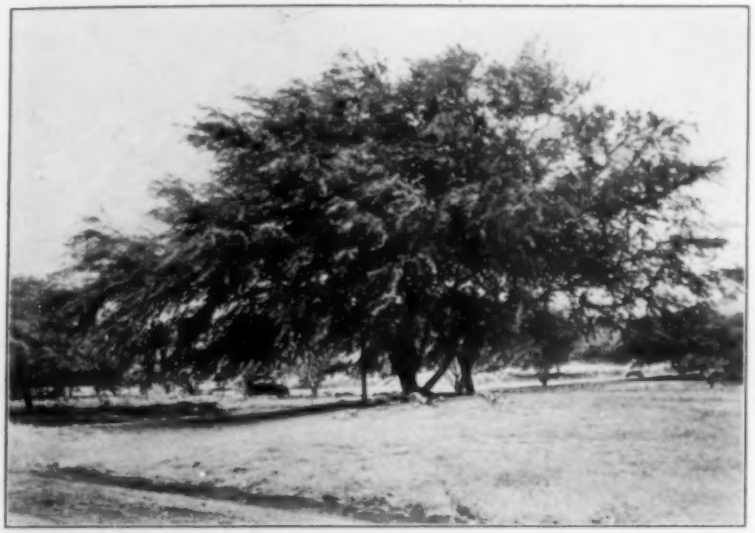


FIG. 12. ALGAROBA TREE (*Prosopis juliflora*) near the College of Hawaii. This tree is well naturalized on the drier sides of all the islands, usually forming a belt near the coast. It is also used as a street tree. The pods are greedily eaten by stock and furnish a considerable portion of the forage in the dry season. The flowers furnish honey, which is an important product on many of the ranches. The native name is kiawe.

This is also called monkey-pod and rain-tree. The flame tree or royal poinciana (*Delonix regia*), familiar to the tourist in South Florida, is a deciduous tree, with very showy scarlet flowers that appear before the leaves. The banyan tree (Figs. 7, 8), with its numerous air roots hanging from the branches, is frequent in parks and lawns. The pepper tree, commonly cultivated in California, is planted along streets and drives. Clambering over a stone wall around Punahou College is a remarkably fine growth of night-blooming cereus (Figs. 9, 10). This cactus blooms en masse only at intervals of several weeks or months, though occasional flowers appear at irregular intervals. When in full bloom the effect is very striking. The large white funnel-shaped flowers, a foot long and several inches in diameter, open after sunset and close the following morning.

FIG. 13. KOA TREE ON NORTH SLOPE OF MAUNA KEA. An isolated specimen.

The accompanying photographs were taken between the break of day and sunrise, and the flowers had partially closed.

One of the favorite drives from the city leads over a pass in the Koolau Mountains. This pass, called the Pali or Nuuanu Pali, is about 1,200 feet altitude. The view from here is unusually fine. The trade wind blows through here with great force, at times so strong that the passage of vehicles is difficult, and pedestrians must make their way by aid of a wire cable stretched along the cliff. A remarkable effect of the strong wind is seen on a waterfall over a cliff to the west of the Pali. The water falls up instead of down. As it goes over the edge of the cliff it is caught by the wind and shoots straight up in the air.

There are two institutions in Honolulu of special interest to the taxonomic botanist. At the College of Hawaii, there is a large herbarium of Hawaiian plants in charge of Professor J. F. Rock, who has studied the flora intensively and has published several memoirs upon Hawaiian plants. Of special interest to visiting botanists are his two books, "The Ornamental

Trees of Hawaii" and "The Indigenous Trees of the Hawaiian Islands," both profusely illustrated from photographs.

The Bishop Museum possesses a large and important collection of ethnologic and natural history objects relating to the Hawaiian Islands and to Polynesia. There is a large herbarium of Hawaiian plants in charge of Mr. C. N. Forbes, who has traveled extensively over the islands and who has published several articles upon their flora.

Professor W. A. Bryan, professor of zoology and geology in the College of Hawaii, has published a book upon the "Natural History of Hawaii" which should be consulted by all botanical travelers.

The U. S. Experiment Station is in charge of Mr. J. M.

FIG. 14. KOA FOREST ON NORTH SLOPE OF MAUNA KEA. The trees as they look when crowded.

FIG. 15. SCHOFIELD BARRACKS. The western range of mountains is in the background, Mt. Kaala, the highest point in Oahu, being at the right. The grass in the foreground is mostly pilipiliula (*Chrysopogon aciculatus*). This is troublesome because the mature spikelets, with their sharp points, penetrate the clothing.

Westgate, formerly of the Bureau of Plant Industry, to whom the writer is indebted for many courtesies.

A fine collection of exotic trees and shrubs is to be found in the Hillebrand Garden (Fig. 11), now owned by Mrs. Mary E. Foster. This was once the home of Dr. W. Hillebrand, the author of the well-known "Flora of the Hawaiian Islands." Another fine collection of trees is in the grounds of the Board of Agriculture and Forestry, on King Street.

The flora in the immediate vicinity of Honolulu is disappointing. Scarcely a native plant is to be seen for several miles around, if one disregards plants of the beach and of the shore marshes. The moist open slopes are taken with Hilo grass (*Paspalum conjugatum*) and vast areas are overrun with guava and lantana (*L. Camera*). I saw enough fine yellow guavas going to waste to make guava jelly for an army. Of 60 species of grasses found around Honolulu, 50 species were introduced. An exotic tree, the kukui (*Aleurites moluccana*) has virtually become a weed, so widely is it introduced. The light green foliage is a striking feature of the landscape (Fig. 39).

An introduced tree of great economic importance is the algaroba (*Prosopis juliflora*), a relative of the mimosas (Fig. 12). This tree occupies great areas or belts in the low land near the coasts of all the islands, especially on the lee side. The flowers

furnish nectar from which an excellent quality of honey is produced—the annual output of the Molokai Ranch being in excess of 100 tons. The pods are eagerly eaten by all kinds of animals and furnish an important source of feed.

Probably the commonest tree in the islands is the ohia (*Metrosideros polymorpha*), a variable species found from sea level to 9,000 feet altitude. The bark resembles that of our white oak, but the flowers, myrtaceous in structure, with numerous protruding stamens, are bright scarlet, or sometimes yellowish, and very showy. The most important forest tree is the koa (*Acacia Koa*) (Figs. 13, 14) and in abundance is probably second only to the ohia (o-heé-a). The wood of the koa is used for cabinet making and for construction. The ukulele, a mandolin-like musical instrument, is usually made of koa wood; and the ancient war canoes of the natives were hollowed out from the trunks of koa trees. The leaves of this tree, whose relatives are mostly Australian, are to us peculiar in that they consist of lanceolate flattened petioles (phyllodea), though the young trees, or young shoots on old trees, show twice pinnate leaves with flattened petioles.

The interior of Oahu is a plateau lying between the eastern and western chains of mountains. On this plateau is situated Schofield Barracks (Figs. 15, 16), where are quartered many of the troops. The open ground here is fine for parade purposes but is covered with a pestiferous little grass called pilipiliula (*Chrysopogon aciculatus*) whose mature florets end

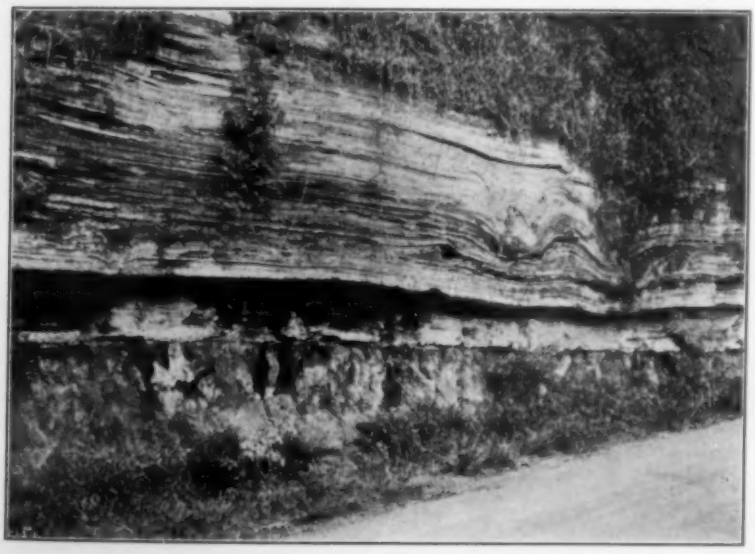


FIG. 16. STRATIFIED LAVA ON THE ROAD TO SCHOFIELD BARRACKS.

FIG. 17. A FOREST OF SCREW-PINE (*Pandanus odoratissimus*) near Hilo.

FIG. 18. VIEW ON MAUNA KEA, AT ABOUT 10,000 FEET, looking south, a small crater in the foreground, Mauna Loa in the distance, a cloud bank between.

in a sharp barbed point by which they easily penetrate the clothing of those who walk over it.

A common grass in lawns, parks, and dry open ground generally, is Bermuda or, as it is called there, manienie (*Capriola Dactylon*). An equally common but worthless grass in the wet regions is Hilo grass (*Paspalum conjugatum*). Both species are introduced.

FIG. 19. VIEW OF MAUNA LOA FROM THE UPPER PART OF MAUNA KEA, a cloud bank between.

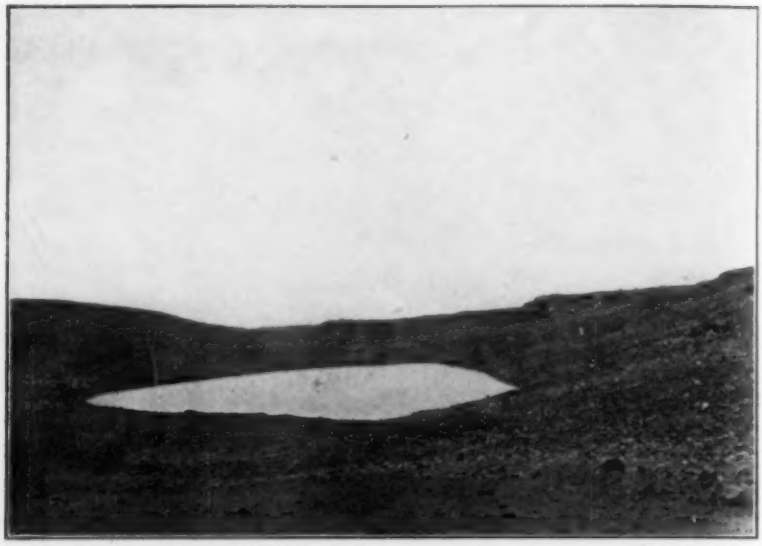


FIG. 20. SMALL LAKE NEAR SUMMIT OF MAUNA KEA. Altitude about 13,000 feet. Because of the porous lava soil lakes or ponds are rare.

HAWAII

The second island visited was Hawaii, the largest and southernmost of the group. This, the youngest geologically, presents greatly diversified examples of lava. We landed at Hilo, the largest town on Hawaii and the second in size in the islands. The rainfall here was excessive and the first thing done was to purchase a Chinese umbrella to protect ourselves against the frequent showers. In the low land along the coast in the vicinity of Hilo is a forest of puhala or screw-pine (*Pandanus odoratissimus*), a monocotyledonous tree with branched

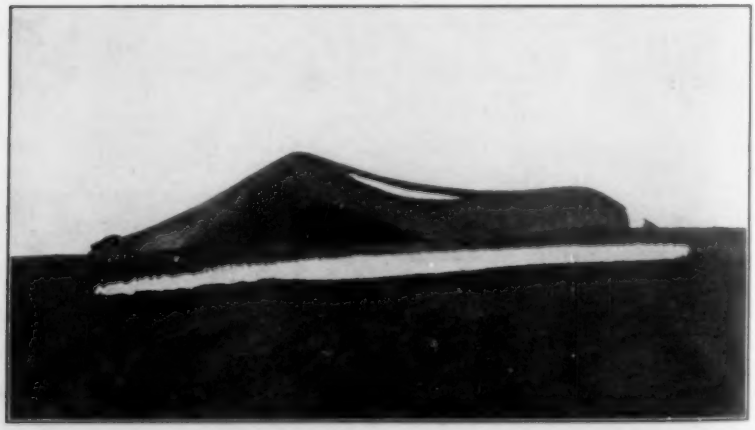


FIG. 21. SNOW BANKS NEAR THE SUMMIT OF MAUNA KEA.

stems, aerial roots, and great compound fruits like pineapples (Fig. 17).

We went by rail to Kukaiau where we were met by Mr. McAllister, manager of the Kukaiau Ranch, who took us to the ranch on the northern slope of the island. On account of the lack of running water rainwater is collected by means of large sheet-iron roofs supported on posts, and conducted into tanks or

FIG. 22. A SNOW BANK NEAR THE SUMMIT OF MAUNA KEA.

ponds. The ranch runs well up on the slopes of Mauna Kea. At the upper stretches, 4,000–8,000 feet, many of the common meadow and pasture grasses of the United States are thriving. Among these are blue-grass, orchard-grass, meadow fescue, meskit or velvet-grass, and Italian rye-grass. Natal-grass (*Tricholaena rosea*) was common at lower altitudes. *Paspalum dilatatum* is giving excellent results as a pasture grass.

The next stage of our journey was the Parker Ranch, the largest ranch in the island. Our headquarters were at the residence of the manager, Mr. Alfred W. Carter, near Waimea. The Kohala Mountains near by are very wet, but much of the land in the interior is dry. The great interior plain between Mauna Kea and Mauna Loa is covered with grasses, composed largely of species of *Eragrostis* (*E. atropioides, E. hawaiiensis*). Through the courtesy of Mr. Carter we were able to visit the summit of Mauna Kea. There are two high moun-

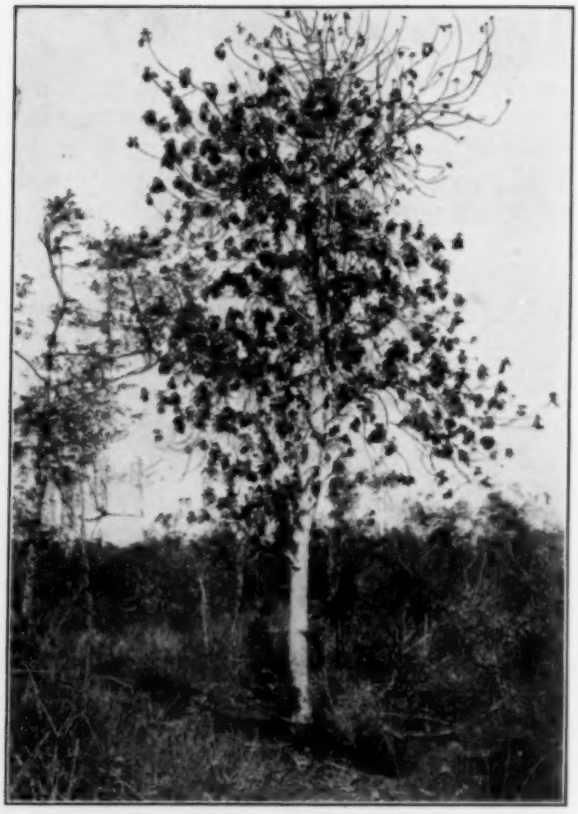


FIG. 23. A KOKIO-TREE (*Kokia Rockii*) IN FOREST ON LAVA FLOW NEAR PUU WAAWAA. An ally of the cotton with large red flowers. Endemic in this region and consisting of rather few individuals.

tains on the island, Mauna Kea to the north, 13,825 feet altitude, and Mauna Loa to the south, 13,675 feet altitude. These mountains slope rather gradually from the sea to the summit. They form an immense cone rising from the floor of the ocean 18,000 feet below the surface, or about 32,000 feet altogether.

We were taken by automobile to the Humuula sheep-station on the south slope of the mountain at an altitude of about 6,700 feet. The following morning we ascended the peak on horseback. The upper stretches, consisting of cinder slopes, are tiresome to travel over, but not dangerous. At about 9,000 feet we rose above the clouds which now lay as a billowy white ocean between the two mountains (Figs. 18, 19). The upper forest consists largely of mamani (*Sophora chrysophylla*). At about 10,000 feet the trees disappear and the sparse vegetation consists of low shrubs and bunch grasses. The latter consist chiefly of three species, *Agrostis sandwichensis, Deschampsia australis,*

FIG. 24. HALAPEPE TREES (*Dracæna aurea*) ON AA (ROUGH) LAVA, PUU WAAWAA. The leaves are eaten by cattle.

and *Koeleria glomerata*. Not far from the top there is a small lake of clear palatable water, an unusual sight, as lakes are rare in the lava soil of the islands (Fig. 20). There are many banks of snow in protected places among the cones on the summit (Figs. 21, 22). There is considerable snowfall in the winter and many banks persist throughout the year.

Our next stop was at the Puu Waawaa Ranch in North Kona on the western side of the island near the Hualalai Mountains. This ranch is owned by Mr. Robert Hind, through whose courtesy we visited the top of the Hualalai Mountains, the highest peak of which is 8,269 feet. The ranch takes its name from an isolated hill or old volcanic cone fluted with deep gullies, the top covered with forest. All the water upon the ranch of over 150,000 acres is rainwater impounded in large tanks, several of which hold 100,000 gallons each. Mr. Hind has a fine meadow of Rhodes grass which yields crops of hay several

FIG. 25. COOK'S MONUMENT ACROSS THE BAY FROM NAPOOPOO. This marks the spot where Captain Cook was killed.

times a year. It is upon Mr. Hind's place that is found the tree cotton or kokio (*Kokia Rockii*), a peculiar plant allied to the cotton, with gorgeous crimson flowers about four inches long (Fig. 23). The trees are scattered in the scrubby timber on rough lava southwest of Mr. Hind's house, but are not known to grow elsewhere. There is also here a forest of halapepe (*Dracaena aurea*), a liliaceous tree resembling some of our western yuccas (Fig. 24). The leaves are fed to cattle when there is a shortage of forage.

The next stop was made near Honaunau in South Kona, at the place of Mr. Jared Smith, formerly director of the Hawaiian Experiment Station. Mr. Smith kindly placed his cottage at our disposal. Being directly west of Mauna Loa, we made a

trip up through the rain forest to an altitude of about 3,000 feet. Ferns were here the dominating feature—a bewildering variety. Near Honaunau is Napoopoo, across the bay from which is the monument (Fig. 25) erected to mark the spot where Captain Cook was killed by the natives in 1779. At Honaunau on the coast is the City of Refuge, an enclosure used by the early Hawaiians as a sanctuary to which those in peril might flee for protection. The walls are twelve feet high and fifteen feet thick (Fig. 26).

We were taken by automobile over an excellent road around the south side of the island to the Crater Hotel near the volcano of Kilauea. The crater is at an altitude of about 4,000 feet and measures about three miles from north to south and two miles from east to west, the floor being nearly 500 feet below the rim (Figs. 27, 28). Near the south end of the crater is the lava pit, called Halemaumau, in which the liquid lava is now in a state of activity, boiling and splashing, and throwing up great fountains of spray. It is one of the most marvelous natural phenomena it has been my good fortune to observe. The view at night is especially wonderful. The red-hot lava breaks on the shores of the lake with a sound like breakers on the sea-coast. Fortunately the lake can be viewed in safety from the rim, as the upheaval of the contents is not violent enough to endanger the onlookers.

FIG. 26. CITY OF REFUGE, HONAUNAU. "A stone wall twelve feet high and fifteen feet thick encloses seven acres of tabu ground; to such sanctuaries women and children, warriors worsted in battle, criminals and others in peril might flee for safety from their avengers." (Bryan, "Natural History of Hawaii.")

FIG. 27. A CRACK IN THE LAVA IN THE CRATER OF KILAUEA.

With the aid of Mr. Short, the kindly keeper of the Crater Hotel, we arranged for the ascent of Mauna Loa. Two saddle horses and a pack horse were obtained at the Dent Ranch near the volcano. We went without a guide, taking bedding and enough food for three days. We reached a resthouse on the east flank of the mountain at an altitude of about 10,000 feet, where we remained for the two nights. The resthouse contains

FIG. 28. EDGE OF A LAVA FLOW NEAR THE LAVA PIT.

cooking utensils, a few articles of furniture, and an oil stove with a supply of oil. Water is supplied from a rainwater tank.

We started on the ascent as soon as it was light the following morning, taking a canteen of water, a light lunch, the plant pick, and our large camera with its tripod. There is no definite trail, but the way is marked by monuments. For three or four miles these monuments are staffs with white metal disks, but beyond this there are piles of stones with a white rag fastened around the uppermost stone. The lava is very rough and is very wearing upon the shoes. There seems almost an infinite variety of lava (Fig. 29) and there are many caves, craters and chasms that attract one for further exploration. Bubbly lava, covering large areas, is tiresome or even dangerous to traverse. What appears to be a hard surface proves to be a thin coating

FIG. 29. LAVA FORMATION ON MAUNA LOA (pahoehoe or smooth lava).

over air spaces varying in depth, but usually not over fifteen or twenty inches. The sudden fall through the crust produces a very disconcerting sensation. Dangerous chasms and caves abound, but may be avoided in the day time by using normal caution. The crater at the summit, a distance of about ten miles from the resthouse, was reached about 2:30 P.M. Time did not permit a descent into the crater, but photographs were taken giving a general view with snowbanks in the distance. About half an hour was spent here. One of my shoes had been dangerously worn on the sole, though thickly hob-nailed. It

FIG. 30. ROAD FROM GLENWOOD TO VOLCANO HOUSE. Ferns very abundant. *Freycinetia Arnottii* climbing an Ohia Tree (*Metrosideros polymorpha*).

became necessary to do something to the shoe to protect the sole. Fortunately I had found a discarded fruit can which we were able to utilize for the purpose, otherwise I should have been in a dangerous condition, miles from the resthouse, on rough lava, with my foot unprotected. We commenced the return at 3:00 P.M., but were able to traverse only about half the distance before being overtaken by darkness. Little progress could now be made until the nearly full moon rose about 7:00 P.M. As

soon as the light was sufficient we were able to go faster, but the monuments could be located only with difficulty. I remained with one monument until Albert had located the next. In order to avoid the dangerous places the trail takes unexpected turns, thus increasing the difficulty in finding the successive monuments. After about a mile or less of this we lost the trail and determined to make for a hill a mile distant which we thought we had passed on the outward trip. This we did and picked up the trail again. However, in a short time we were again lost. After searching through an entire circle for the next monument we decided again to go eastward toward a distant hill from the top of which we might determine our position. These trips across the lava were exceedingly tiresome and were accompanied by no little danger. We got into bubbly lava from which there seemed no exit and in which we were threatened with engulfment at every step. Chasms and pits were avoided by a hair's breadth. The slanting moonlight made everything shiny bright on one side and black as night on the other. Frost was settling on the rocks, adding to the confusing reflections. At sundown we were so tired we could hardly put one foot before the other. But the dangers of the night travel banished our fatigue for the time being. We finally reached the hill for which we were making, ascended it only to find ourselves looking down into a crater and with no view to the east. We were lost, cold, hungry, thirsty, and ready to drop from exhaustion. To remain inactive till morning invited death from the cold. As it was necessary to keep moving, we decided to proceed eastward in the direction we thought the resthouse to be. After descending the cone Albert thought he saw a staff in the distance to the north. Examination proved the correctness of his surmise. The trail was recovered! We were able to follow the monuments, but it took us two hours more to reach the resthouse. The piece of tin on my shoe had worn through and the leather of the sole was at its last point of resistance.

We returned to the Crater Hotel the following day none the worse for our adventure.

A short time was spent at Glenwood with Mr. Thompson the superintendent of the station located here, a branch of the U. S. Experiment Station at Honolulu. We are here in a very wet region. Visitors to the volcano usually come by rail from Hilo to Glenwood, the terminus, and continue by automobile bus over a beautiful fern-lined road to the hotels (Fig. 30), a distance of 8 miles. Or one may go the entire distance from Hilo by auto, about 35 miles.

(To be continued)

THE TRACK OF EVOLUTION

By Professor S. N. PATTEN

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IN a recent talk with a friend about the lack of sympathy between the workers in physical and social science he asked, "What contribution since that of Malthus has been worthy of consideration?" Malthus, he admitted, helped to arouse the leaders of biologic thought, but who, he asked, had given a definite contribution since that time? The question demands an answer, or at least some discussion of the points involved. It must be admitted that the economists are defective both in their reasoning and in their psychology, but it should also be recognized that there were obstacles to the use of objective measurements in social science which were hard to surmount. Until the pathway is cleared objective measurements, while seeming to add to the clearness of thought, have in reality added to its confusion and furnished more meager results than did a legitimate use of older methods. There have been endeavors to use the method of physical science, but real students have found that beneath the formula taken from mathematics or physics lay hazy ideas and a species of dogmatism that prevented an open-minded consideration of the facts. Every crank, and his name is legion, poses as a scientist and has his formulæ modeled after the latest statement of scientific truth, but this pretense has only been a cloak for ignorance and dogma. If the scientist suspects the economist, the economist in turn suspects the new-comer who trades in the symbols of physical science. Some progress has thus been made even if the results are not so definite as those of physical science.

The defects in the social sciences are due to the imperfections in the physical sciences on which they are based. The economist must follow, not precede, the physical scientist? If the economist fails the original fault is not with him, but in the partial development of the sciences on which he depends. Subjective standards have been adhered to because of the lack of objective data. In many fields one has to choose between making physical science and falling back on the loose basis of thought on which the older economic science rested. It is no wonder that under these conditions economics has failed in its

main mission and its workers are compelled to endure the sneers of those in more fortunate fields of work.

Were I thinking only of making this complaint I would have remained silent. There seems of late some alterations in related sciences raising the hope that a new epoch has come in which the social and physical sciences may cooperate for a common advance. The route to this understanding I shall point out both as to where agreement has been reached and where a gulf still remains. Economic change must be one of a group of changes each of which is an essential step in progressive evolution in order that its conclusions may be put on a par with other contributions. I found that a start could be made in this direction, but no full solution was possible while certain views of physical science persisted. The law of diminishing returns assumes that men have a few stable wants, in the satisfaction of which a keen and destructive struggle arises. The increasing demand for any commodity causes an extension of its production to a point when diminishing returns begin. Men, however, gain relief by changing their wants and thus bringing into use new natural forces. An evolution is thus forced from old objects of consumption to the new, and from objects of which nature is less productive to those of which the yield is more generous. Potatoes and sugar may displace meat and wheat bread. I had little difficulty in proving this point, but the next step was blocked by a supposed physiological principle. It was contended that the cheap food made a low type of man. The rare foods like meat and bread stimulated a higher sort of energy and gave to those who use them a physical and mental superiority that was decisive in every world contest. The Irish potato-eater was doomed to a subordinate position in comparison to the English, who used a more costly food. Economic progress and physical progress were thus put in opposition.

This obstacle no longer exists, or at least is in a fair way to be removed. The cheaper foods have of late proved their worth. The vigor coming from the use of meat is in no way superior to that of bread, potatoes, or rice. If but one article or some few articles were used, wheat bread and meat might prove their superiority to the potato or rice; but as the variety of food increases the deficiencies of each sort of cheap food are made up by the excellence of some other food. The cheaper diet as a whole proves its superiority over the old meat and bread diet.

The prevailing theory of the past also assumed that to be well-nourished and prosperous led to indulgence, dissipation, and degeneration. The strong, vigorous person was assumed to

be he who was somewhat underfed, or at least so poor that over-indulgence was impossible. There is a measure of truth in this view, as also there is in the statement that the users of dear food, bread and meat, have been the superior races. By heredity our stomachs are used to coarse food. The primitive man could only occasionally secure the concentrated food the prosperous now use. He faced periods of actual starvation each year, and thus the indulgence of one season had its influence counteracted by the want of another. Our stomach troubles are due to a change to a concentrated diet, a change which was promoted by the belief that the dearer foods gave a superior energy to that derived from cheap foods. The measure of energy is not the quantity of food taken into the stomach, but the quantity of pure blood that results from the digestive process. There are also numerous glands the right action of which is an element in blood values. The best food when eaten too freely may be turned into toxins, and thus be harmful instead of beneficial. This is especially true of meat foods, which are so liable to be transformed into noxious compounds.

The word toxin describes the injurious contents of the blood, but we have no term that designates its beneficial contents. We talk in terms of fat, oxygen, protein and carbohydrates, but stop when the peculiar function of each has been described. To supply this gap and to enable me to state my theory in simple terms I shall call all the ingredients of the blood that promote activity "nutrins," and thus make a clear contrast between the nutrins that increase energy and the toxins that depress it. The man improves as the nutrins in the blood increase. High-priced food, indigestion, and toxins represent the elements adverse to the growth of energy, while cheap food, a varied diet, and more nutrins are its upbuilding forces. We can, if we will, study each of these elements by the method of physical science and remedy each defect. Much has been done in all these fields in recent years. The war has forced each nation to solve its food problem, and to make the people's consumption of food harmonize with known facts.

"Consciousness," says a recent writer, "is a response to environmental stimuli." The environment excites the nerves, and nerve evokes consciousness. This theory has come down to us from the time of Locke, and is the standard explanation of psychic phenomena. The mind is a blank except as it gets a content through nerve excitation. These nerves are a biological inheritance, a mechanism that has taken ages to develop. By them the external stimuli and the internal response are brought into harmony. Are they the source of this internal response,

or do they merely direct a pulse that has an independent origin? Is consciousness a chemical transformation or a biological mechanism? Are its antecedents in the blood or in nerve irritation? The best answer to these questions comes from watching the action of glands and in measuring their influence in creating states of consciousness. The glands accumulate their material and either overflow by the increasing pressure of their content or discharge as the result of nerve stimuli. If it is a self-discharge we dream; if the discharge results from nervous stimuli thought becomes logical and adjustive. The nerves are thus a mechanism not for creating consciousness, but for making thought currents run parallel to external events. They conserve life, but they are not its source.

If this explanation is correct the antecedent to consciousness is a gland discharge creating a pulse that becomes thought through the nerve mechanisms turning the pulse into motor power. The content of a gland is like the steam in a boiler, which by itself merely has explosive power, but which by the mechanisms of the engine is transformed into a steady working force. Nerve development, like improvements in the engine, increases adjustment as the engine creates force, but in neither case are they the seat of the ultimate power. No explanation of movement is possible in terms of engines or nerves. This is readily seen in the case of an engine. Is it not equally true of nerves?

Bear in mind that this is not an attempt to explain consciousness without nerves, but an endeavor to show that explanations of consciousness merely in terms of nerves is doomed to failure. Such explanations lack the true starting point and hence fail to connect consciousness with its chemical antecedents in the blood. From blood to gland, from gland to pulse, and from pulse to nerve reaction is the series through which our life processes go. The pulse in terms of consciousness is emotion; nerve excitation becomes ideas. When the two blend we have the higher life for which we yearn. Each pulse starts as emotion and is transformed into clear thought as the various nerve reactions determine the channel in which it moves. If this be true, dreams and wishes represent the early stages of thought movement when the emotional pulse is dominant. The clue to their origin lies in emotions that are non-adjustive, and not in the useful reactions which harmonize life with its environment. We must start with the glands and connect them with dreams and wishes.

If sex discharges result in sex dreams we have a ready

means of connecting gland activity with conscious emotion. Even if it be admitted that some dreams are not sex dreams they undoubtedly are the most elementary of our dreams. Here plainly a discharge antedates consciousness and colors its content. The philosopher Kant claimed that space and time were subjective forms, and thus the ultimates of thought. It would be nearer the truth to say that sex images are thought's ultimates. The pulse starts in a movement towards sex images, and would end there if our inherited nerve mechanisms did not censor the pulse and force it in other directions. Conscious thought has a foundation in sex but a superstructure of sense impressions. The external elements are magnified because of their usefulness, while the internal are distorted or suppressed.

It is worth asking how perfect these sex images would be if no sense impressions came from the outside to make them definite and clear. Our dreams are not purely subjective. Suppose a healthy child should grow up with no sensory nerves to bring in external impressions, but with perfect gland activity and a well-developed sympathetic nerve system, what pictures would accompany its sex discharges? How far could it go towards creating definite images? What this child could do would show the pulse forms as contrasted to the content due to sense impressions. We thus come to a problem akin to that of Kant. Thought would be a combination of pulse forms and sense data, but these forms would not be transcendental in origin, but the result of sex evolution. Each clear thought would be partly pulse and partly sense; the vital element would be in the one, the utility in the other. The elements of the dream are beneath our waking thought, but its sense content is so fully overlaid that the dream element is confused with the inflowing sense impressions. Though censored and depleted, the dream form exists and is the vital antecedent in all our thought. The nerves dominate, but they do not originate.

This view involves a type of thinking that is old, for it assumes there are native elements in mental activity not derived from the senses. Instead of a blank mind there are inherited mechanisms which determine the types of thinking. But these forms are not transcendental, nor do they need external stimuli to excite their activity. The forms of thought are independent of and antecedent to the concrete additions that come from sensory sources. The new view differs from the old in not starting from abstract concepts like space and time, but from concrete images due to sex and fear. Both sex and fear images are evoked by internal awakenings and not by external data. Here are origins of thought that heredity could create, and if they

are given the more abstract relations could be readily derived from them. It is customary to describe sex imagery as instinctive, but this is merely to name it without giving any explanation. Animals do things with precision for which they have no experience to guide them. Are they merely mechanical reactions or are these animals aided by a picture of the act by some inherited mechanism? Can they dream of what they are to do as men dream? Can they wish and thus anticipate events, or does some blind force drive them to their deeds? To give animals a dream life accords with what we know of our mental activity and breaks down a barrier between their thought and ours. Sex and fear are elements in all conscious life. Is it likely that the imagery they evoke appeared only in human beings? Is it not more probable that their anticipatory dream life is more specific than ours, and thus is more of an aid in the necessary acts on which their lives depend?

Be this as it may, certainly the wish with man goes before the act, and the wish in turn must have a visual antecedent by which it is aroused. These antecedents need not be definite. There is no need of having the power of throwing a beautiful woman on the mental screen to make sex wishes a force. But the elements of form and beauty must be there which slight additions from external sources make definite enough to direct sex wishes. Beauty is light and color attached to some object. But the origin of our concepts of beauty and worship shows simpler objects than woman first arouse our admiration. Men worship light, movement and color in their earlier religion and seek to identify themselves with these primal elements. They also worship a sun god before they are aware of a God of Justice. The light, the heat, the sound, the highly colored, the oval, the disk, the awesome, are early objects of appreciation. All these an inherited mechanism could form for us independent of sense impressions. The series in a sex dream may be thus described—first a bright spot, then a highly colored view which draws the observer to it by a magical force, the view becomes a landscape above the horizon of which the sun appears. The sun becomes a god, a hero, or some familiar form of super life. Memories, judgments, and censorships play a more effective part as the dream proceeds. And yet its course is fairly constant, and from it we can recognize the internal elements that through heredity antedate our sense impressions.

The path of a fear dream is equally clear. It starts with a dark spot or cloud which turns into objects of terror as they approach. Movement is suspended and vain endeavors to escape are made. Then comes a falling sensation. A bottomless pit

opens up, but before the bottom is reached the spell is broken and the dreamer awakes. Here we again have a series that an inherited mechanism could produce. As with sex dreams external elements are readily admitted into the picture and blended with it, but the essentials come not from external impressions but from internal sources. They represent discharges due to pressure, and not nerve reactions excited by external stimuli. It is not difficult to separate the effects of pressure discharge from nerve reaction if we once get the key to their explanation. The antecedent of the one is in the blood, while the other has its origin in the nerve cells. When the two blend we have conscious thought. They are isolated only in dream life.

If we think of consciousness as gland discharge we have a high or low threshold of consciousness as the pressure is great or less. The high pressure gives a bright coloring to our emotions, and from them the sex series starts which we interpret in terms of light, the sun, God, and beauty, with woman at the end of the series. The low pressure in contrast to this gives black spots and heavy moving lines. These become snakes, bears, dragons, demons, as we increase the indefiniteness of our interpretation. For several years I was troubled with dizziness and am therefore familiar with the elementary images due to a low threshold of consciousness. A slight attack makes external objects seem to whirl. With a worse attack heavy black lines fly about in the field of consciousness. These a diseased mind mistakes for snakes. If the attack becomes worse, darkness engulfs and an unconscious epoch follows. It is these dark pictures that we associate with evil. The bad is always pictured with heavy black lines, and thus seems hideous. In reality, however, it is the beautiful woman who is the tempter, while the homely woman is the saint. Could there be better evidence than this to show that our dream images are due to inherited mechanism and not to sense experience?

This proof can be carried a step farther by analyzing the content of the glands when pressure forces their discharge. If the content is toxic a low threshold of consciousness results, with the wiggley lines which readily turn into snakes and dragons. If the gland content is nutric a high threshold results, with light, beauty, God, and woman. The two series flow from the two levels of consciousness, and each has an independent mechanism due to heredity. The two flows of conscious pulse intermingle in many ways, and out of this comes the complexity of emotion and thought. There are, however, four elementary movements, one of which can be recognized in any thought movement.

The simple movements are from light to sun, power, and sex, or from dark lines to snakes and demons. Changes, however, can be made suddenly from one level to the other, from which a complex movement results. The bad pictures may suddenly be changed to bright ones, and then we get the concept of hero, Saviour or Redeemer. Or the movement may start on the higher level and then dip down to the lower level. We then have a crisis out of which the thought of self-sacrifice comes. If we picture these in terms of gland activity any of these movements could readily result, and thus an explanation given that does not involve any mysterious elements. When we understand the transformations of the blood, the discharge of glands and the action of toxins and nutrins, each step can be readily followed and the antecedents of consciousness correctly presented.

If light has been thrown on the physical mechanism antecedent to emotion, the next step is to offer some explanation of the nature of a wish. Wishes are emotion directed to some sensory end. A wish is thus not pure emotion, but emotion mechanically directed to some object. Dr. Freud has been a great aid in separating wishes from pure emotion on the one hand, and from motor activity on the other. We must now ask whether wishes are to be regarded as a nutric discharge or a nervous reaction. The best answer to this are our appetites. The mere sight of food arouses not merely a wish for food, but a gastric flow in the organs where food is digested. The gastric flow does not depend on food contacts, but on food wishes. If gastric flows and food wishes occur together, is it not a simpler explanation to say that the flow is the cause of the wish than to seek an independent origin for wishes? And if this type of wishes has gland discharges as its origin, need we look farther for the source of other wishes? A dream would then be a form of gland overflow, while the wish is the same discharge excited by external stimuli. The wish thus has a direction which dreams lack. Good dreams and good wishes have their origin in these pressure overflows. Bad dreams and depressing fears arise from some toxin in this discharge. The failure to discharge and the overflow start mental activity each of its own kind.

The same reasoning would explain why our dreams are wishes and why repressed action tends to become the content of our dream life. In action we drain the surplus flow from the glands aroused. A refusal to act leaves the glands of the repressed parts full to the point of overflow. We go to sleep with the dominant part of our waking selves drained of its surplus

while the repressed parts are full to overflow. Is it a wonder that when the drained parts are recovering their surplus in sleep that the unused parts should overflow and send our emotions along forbidden paths? The sleeping self reverses the waking self because the exhausted parts lose their dominance, and thus their power to censor.

It is not claimed that the preceding discussion has cleared away the difficulties of a rational explanation of consciousness, but it is hoped that a viewpoint is attained through making such a solution possible. Nerve psychology explains how consciousness is aroused rather than its physical antecedents. If the antecedent of conscious action is a discharge and not a nerve reaction; if it is a chemical change in the blood rather than an inherited nervous mechanism, the physical basis of consciousness can be traced through the steps from the intake of food to the result in action. The food becomes blood, and blood becomes nutrins or toxins. They accumulate in unused glands which discharge either through pressure or nervous excitation. These discharges arouse emotions which excite dreams if the discharge is through pressure, and conscious thought if the discharge results from some nerve stimulation. The nerves thus direct consciousness, but do not create it.

I have stated the contrast between the action of nerve and gland to bring out the elementary function of each. To ask whether the antecedents of consciousness lie in the sympathetic or sensory nerves would involve the same points as to ask its relation to glands and nerves. The sympathetic system controls gland action, while the sensory system directs motor action. The one represents life processes, the other those of adjustment. It is needless to ask what consciousness is or where is its seat. We can, however, learn what physical processes precede and what follow its appearance. This is what I mean by the track of evolution. Improvements start in economic changes reducing the cost of food, saving waste, and in increasing personal efficiency. A group of acquired characters is thus created which become inherited traits only by the slow process of physical evolution. The stomach, the blood, the gland, and the sensory nerve are gradually transformed into more effective means of promoting evolution. Through them we increase our knowledge of external processes from which new economies in food and greater personal efficiency result. In this way an economic theory of progress becomes a complement to current biologic theories, and together they give a clearer view of evolution than either in isolation presents.

SCIENTIFIC MANAGEMENT AND SOCIALISM

By MALCOLM KEIR

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APPARENTLY scientific management is as remote from socialism as the east is from the west, yet in reality there are few movements more effectual in promoting government ownership and operation of industry than the one fathered by efficiency engineers. Nothing could be further from the thoughts of the promoters of science in business, indeed, to many of them nothing could be more abhorrent, than the social reconstruction that logically completes their work; equally upon the other hand, socialists little dream of the powerful cooperation that will be given their aims by the men who are now attempting to reform business methods; nevertheless, the end of scientific management is socialism, for the one leads to the other in the evolution of industry. One route by which this end is reached is through the elimination of skill, another is by means of federal supervision of the foreign trade that arises as a result of the overproduction incident to the introduction of efficiency methods, and the third is the tendency that scientific management has toward installing automatic machinery, a trend that if carried to its logical conclusion—complete automatic production—would require government ownership. It is upon these three features of scientific management, namely, the elimination of skill, overproduction and the replacement of men by mechanisms, that we base our prophecy that scientific management leads to socialism. Since there are almost as many varieties of socialism as there are socialists, it should be understood at the outset that when that term is used we mean the government ownership and operation of the necessary means of production.

Scientific management has been welcomed by manufacturers because it places within their hands a new and powerful tool whereby the strength of skilled labor can be undermined and the power of employers strengthened. Ever since one man worked for another the interests of the two have been opposed in the struggle to determine wages, and a large factor in the favor of the workman has always been the skill he possessed and which the employer was forced to use, and to reward. As

long as production was simple, the recompense of any laborer was usually in proportion to the amount of skill involved in his job. The complexity introduced into production by the invention of machinery served to heighten the importance of this ancient rule, for although machines suddenly at one blow usurped a great amount of traditional skill, nevertheless, they did not eliminate entirely the employers' dependence upon skilled labor, with the consequence that under the mechanical *régime* ushered into industry by the industrial revolution, a man's wages more than ever depended upon the skill involved in his job. Where little or no special deftness was required the machine owner took almost all the proceeds of production, giving the laborer just enough to maintain existence. In the first flush of power in England, manufacturers went even further than this, for they paid workmen less than the exigencies of existence demanded, trusting to charity to make up the difference between wages and life necessities, a situation which was not relieved until the compulsion of national legislation and the demands of labor unions forced manufacturers to relinquish some of the advantages of their position. Highly skilled workmen, on the other hand, were able to demand and receive a share in the proceeds of production, greatly in excess of bare subsistence wages. Skilled workmen have a monopoly and as a result exert monopoly privileges; the extent to which they share in profits is determined by the degree of their monopoly.

Inasmuch as this citadel of labor prevents manufacturers from securing to themselves most of the gains of business, it stands as a constant challenge to them and spurs them onward to make every possible inroad upon their adversaries, by inventing and adopting devices which will eliminate the dependence upon skill; after years of assault of this character, although the band of men within the beleaguered fortress has grown smaller and smaller, the stronghold still maintains its integrity. *It is at this point that Scientific Management comes to the aid of machine owners, for it is virtually a new mechanism that transfers skill from the operatives to the operators, or from another point of view, it is one more step in the subdivision of labor whereby the power of workers is lessened and that of employers strengthened.*

In the past, methods of work or the manner of using a machine has been left largely to the laborers concerned, and manufacturers exercised little supervision over the exact way in which a man turned out any job. The men, unaided, developed

"rules of thumb" and secret practises satisfactory to themselves and also to the management, although the office did not know just exactly what went on in the shop. A considerable body of knowledge of this sort rested with the men and constituted a respectable portion of their "skill." Efficiency engineers set themselves the task of bringing this art under the control of the management; the first studies, therefore, were aimed at finding out just what the men knew about their jobs, and classifying, indexing and standardizing the information obtained. Then a first-class workman was studied minutely in every phase of his operations, and the motions, appliances and methods of his work analyzed to the last detail, and, finally, all the parts were synthesized into a new whole which was better than any operation ever performed by any man by himself. Thereafter, this new method of work became the standard of every worker in the plant, for no man was allowed to perform his task any longer just as he pleased, but was required to follow the rules laid down by the management; in other words, the management took over most of the "skill" and the men merely followed instructions. Scientific management, therefore, was a tremendous assault upon the bulwarks of skilled workmen, and after it began to function fully it actually permitted men of much less experience to carry out the duties which formerly required highly trained men; for instance, day laborers could be put on the more simple operations of machine work, formerly the job of well-paid machinists.

Yet, nevertheless, when first introduced, scientific management increases rather than decreases the laborer's share in the proceeds of production. Efficiency engineers gain by their analytic methods a greatly enhanced out-put with the same machines and the same labor. Of the profits which arise from the augmented product, the management usually takes two thirds and gives the men one third, a fair enough division, since part of the return may be considered as interest arising from the investment in the new "mechanism," and in addition since the men themselves did nothing to create the conditions under which alone the enlarged production was made possible. The one third share of the men so increases the wages of the workers over the customary pay for their particular class of labor that as a rule they are perfectly satisfied with the arrangement. Consequently scientific management is unlike any other innovation that has ever been introduced in industry, for all other improvements have borne harshly upon the workers immediately involved, although in the long run labor in general

was benefited; on the contrary, scientific management is advantageous to the workmen who are directly involved in it. Despite high wages, the production under scientific management is so greatly increased that the manufacturers gain a lower labor cost per unit than they formerly enjoyed; high wages in fact are granted to the men as an inducement to work faster, so that this desired output may be attained.

The secret of the success of efficiency engineering lies in the great unevenness of industry. Every step from management on the verge of bankruptcy to the most highly efficient may be found and every stage in industrial evolution from complete hand work done at home—the manufacture of women's neckwear, for example—to factory operation in which every process may be performed by machinery, as the shoe industry illustrates. *Scientific management brings profit to those few who adopt it because the great mass of their competitors is without it.* The price of the product is set by the cost of production found in the great number of plants of *average* efficiency. The scientifically managed plant with a lower cost of production than the average may do one of two things; it may lower its selling price so as to capture the whole market and make its profits by the quantity sold—after the manner of Henry Ford—or it may be satisfied with making a large profit on its smaller volume of sales by leaving the price where it is set by competitors. The second is the more usual method of procedure, because to run a very large business requires organizing ability of the highest and rarest kind, and, furthermore, the second method yields a comfortable profit without involving anywhere near as much work. However, the first method is the safer, for it gives a virtual monopoly when it is easy to acquire, since scientific management is like a machine, if it isn't "patented" and kept for one's own personal advancement, one's competitors will seize it, and hence eventually it will lose all strategic value to the first owner. If a manufacturer chooses to install scientific management and does not attempt to grasp the full monopoly privilege inherent in its possession, but uses it as he would any other piece of new equipment, he can make it pay handsomely as long as other men in the same line of business do not hire an efficiency engineer, but, just as in the case of any other mechanism, every competitor will be forced to adopt it eventually or go out of business. The profits that arise from the use of scientific management vary inversely with the number of users—to talk mathematically—hence *the increased production due to efficient methods will itself, in the long run, yield no financial returns.*

What then will become of the workman's extra wages? The answer is obvious; that, as the enlarged profits which permit bonus wages to be paid disappear, the additions to wages over and above the market rate will also vanish. The laborer will be worse off than he was in the beginning, because he will have sacrificed to a planning department belonging to the management his "skill," by which he forced high wages; and the pace at which he worked at first in order to gain extra pay will have become required without the greater compensation. Here then is the first place that scientific management will lead to socialism; the men working harder than ever, but witnessing a constant shrinkage in the contents of their weekly envelopes, yielding more and more of their traditional skill to the accurate studies of the "office" and seeing their jobs handed out to less and less trained men hired at lower wages, realizing that the employer is attaining ever greater right to the total income of production, the men will demand that the government regulate industry.

The first form such regulation will take will probably be a national minimum wage law. Once such a law is granted, it will be revised continually in order that the minimum may be raised to ever higher levels. The workers ought to be able to secure this boon in the face of the opposition of manufacturers, because the men will have the vote and can hold a political ax over congress. Massachusetts has long been acclaimed as a leader in industrial legislation whose object is betterment of labor, not because the state is any more enlightened than others, but largely on account of the fact that 50 per cent. of the people in gainful occupations are engaged in manufactures and all but 5 per cent. (4.9 in agriculture) of the remainder are more or less closely associated with the factory enterprises. The workers of the state, therefore, who are voters, have a close interest in labor laws and can force them from the legislature. Not only may the artisans of the future seek to enforce national minimum-wage laws but also they may endeavor to curtail production by lessening the hours of a work day, and make six or four hours the legal work period over the whole country. The profits of the manufacturers, already cut down by competition, will thus shrink further under the enforced higher wages and shorter hours, so, in some future crisis, when aroused labor makes greater onslaughts upon profits, the manufacturers themselves may be glad to sell their plants to the government under which they then may become managers with a salary.

The discontent that must eventually be felt by workmen on

account of scientific management may be translated into action such as we have noted, and the logical outcome of the movement of the workers against the efficiency of the managers seems to be government ownership and operation of industry—which state is synonymous with socialism. However, the manufacturers of the future may be shrewd enough to foresee this result and take measures to turn aside labor's dissatisfaction.

The scheme that most probably will appeal to employers as a way out of their difficulties is profit-sharing of some kind, even though the name and aim may be disguised under a different term. If the employees share in the profits of a business, that enterprise is socialized, and the first step toward more comprehensive socialism has been taken.

Likewise *any* device that may be adopted to appeal to laborers must have in it some germ of socialization, for otherwise the workers would disdain it. Hence any attempts manufacturers may make to soften the effects of scientific management only lead them into paths whose final goal is socialism.

The elimination of skill is by no means the only route by which scientific management leads to socialism, for not only do efficiency engineers strive to get rid of operations requiring skill, but they also bend all their energies toward increasing production. This fact gives rise to a set of forces which tend to operate in the direction of socialism.

Before the opening of the Great War, when few industrial plants were operated by efficiency methods the nation faced the necessity of a market abroad, because the mills had reached the point where their production just about filled domestic needs. The home market, therefore, was unable to absord a surplus, with the consequence that foreign trade became most attractive to American producers. Into this situation we are now introducing scientific management, one of whose tenets is an increased output often double, sometimes triple the average of previous experience. Just as long as the new scheme of organization is limited to a few concerns, industry as a whole is little influenced by the augmented production, but, inasmuch as all concerns must eventually adopt scientific management, the nation is facing a future period when production as a whole will be at least two or three times what it is at present. The multiplication of products will tend to lower prices and thus broaden the domestic market, but it seems hardly probable that the home consumption can absorb the entire surplus, especially since the nation had already commenced to feel the effect of

glut, even before the operation of new methods of management influenced out-put. As a result, it does not take a very keen vision to predict that the United States must take an ever increasing interest in foreign trade, a movement that will precipitate an intense commercial struggle between nations for supremacy. In order to meet strenuous international competition, American factories must be so organized that they may be treated as a unit, and all wasteful practices—such as cross freight, unnecessary transportation of raw materials to plants poorly situated or needlessly long hauls for products destined for export—may be eradicated. These ends may be attained at first by government control, but regulation of industry will usually lead to ownership because mere federal methodizing will never prove entirely satisfactory. We have amply proved this in the case of railroads, for, beginning by loose regulation, federal authority over steam-railway transportation has been tightened constantly, until now even railroad presidents themselves declare that they see no relief in sight except such as may come through government ownership. In a similar manner the mere shadow of government, at first extended over foreign trade, will take on more and more substance until—as is the case with Germany—the state itself shall become the virtual dictator of foreign trade. In order to carry on its affairs satisfactorily, the government agencies in control of foreign traffic must reach backward inland to regulate the sources of production until individual factories come under its powerful sway, and then socialism will be here, although it may be called by some other name.

Starting with scientific management we have arrived at socialism a second time, but our story is not yet done, for there is a third condition that grows out of efficiency methods, and this third one, the increased use of automatic machinery, like the other two, is completed by socialism.

One of the foundations of scientific management is a study of the motions necessary for the carrying on of every process in the making of an article; it aims to simplify the motions continually in order that they may become most nearly mechanical. The next step, namely, adjusting the machine to give the mechanical equivalent of the motion instead of trusting to a man, is an easy one. Scientific management, therefore, greatly hastens the transferal of skill from men to mechanisms, and brings forward more rapidly the day when all machinery will be automatic.

It is not easy to accept this concept, for it seems like fly-

ing in the face of truth, yet we can see the tendency toward automatic machinery in every industry around us. Not many decades ago a weaver took care of just one loom, and the passing of the shuttle bearing the weft was a hand operation. One of the first improvements in looms was to kick the shuttle across the warp by a mechanical device and then power was applied to the whole operation of the loom. Later improvements augmented the number of shuttles from one to half a dozen, still later refinements threaded each one of the six shuttles automatically. Furthermore, when any thread breaks, the loom stops automatically and another machine worn on the weaver's thumb reknots the broken strand. Instead of requiring one weaver to each loom modern mills need only one for every twenty machines. It is not an idle dream to suppose that some day no men at all will be necessary for loom operation. Take another illustration from among a great number. To make a screw once required a man and a machine for each operation of heading, tapering, threading, slitting the head and cutting off, or one man had to readjust one machine five times for the five operations. To-day one machine—the turret lathe—performs all five with one adjustment and in addition feeds itself with raw material. As a result, one man can take care of ten screw machines. Is it impossible that some day that one man will not be needed?

Many people will accept the eventual automatic production of all products whose processes require mechanical repeated motions, but to them it seems incredible that machinery can ever displace men entirely, because so many operations as now conducted necessitate judgment, a faculty no machine can acquire. Nevertheless, for every action that demands judgment, there is some mechanical equivalent that will bring about the desired result. For illustrations, we are familiar with the perforated paper roll that plays pianos, the wax record that does the work of stenography, or the mathematical combination of gears that adds, subtracts and multiplies. There may be a small irreducible minimum of labor essential say for the starting and stopping of machinery, but the great mass of labor will be set free.

This stage of industry will be coming to the front rapidly in the days when scientific management is universally adopted, for efficiency engineers bend their energies constantly toward making motions simpler, easier and more mechanical in nature, and then replacing the man by a cam or a gear which performs the action better than any man could. Scientific management,

therefore, greatly promotes the use of automatic machinery. It is clear then that as the tenets of efficiency engineers are accepted by all manufacturers and as, through the engineers' studies, machinery more and more completely ousts men, that the profits of industry will go to the owners of machines even more fully, until, if allowed to go to the logical end, *capitalists will absorb all the proceeds of production because there will be no factory laborers.* To place the control and the emoluments of industry in a few hands, because the few have the money to purchase the needed automatic machines will frighten people for the reason that the few could exercise a terrible power over the many; therefore, the many will insist that the automatically operated industries be owned by the government or in other words by themselves. This means socialism.

The government ownership and operation of industry—or in other words, socialism, therefore, grows out of scientific management by three different branches. Inasmuch as scientific management tends to eliminate skill, it may come about that labor will try to retain its hold on high wages through government interference with industry; furthermore, since scientific management goes in the direction of over-production, the United States must become an exporter and, in order to compete, the government must control and perhaps endeavor to make operations as simple as possible, and when it attains the desired simplicity, change the operator from a man to a mechanism. If this tendency ever becomes a universal fact—that is, all industry conducted by means of automatic machinery, the government will be forced to own and operate industry because to place such power in private hands would be too dangerous. Because scientific management as a movement is yet young, it is worth while to make this examination into its tenets and to point out its tendencies, for our attitude toward it can then be based upon reasonable ground. If you favor socialism you ought to uphold scientific management, but if socialism is a nightmare to you, then you should condemn this new industrial revolution. It makes little difference whether or not you are pleased with scientific management because it is in industry to stay, for the same reason that machinery has been maintained; it is the most efficient method of production. Since it is economic it must become universal, and when it is everywhere employed some degree of socialism must prevail.

FAMILIES OF AMERICAN MEN OF SCIENCE

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III. VITAL STATISTICS AND THE COMPOSITION OF FAMILIES

IT has been claimed that children of older parents are physically and mentally inferior. Conversely, C. L. Redfield in a curious book entitled "Control of Heredity" and in various articles argues that men of distinction are likely to be born when their fathers are old and that their performance is due to inheritance of the experiences gained by their fathers. If the age of the parents affects the constitution of the children, this clearly is a matter of importance, particularly if the principles of eugenics are enforced either by law or by sentiment. But at present we have no scientific information on a problem which could be solved by statistical research.

The fathers of 865 leading American men of science were on the average 35 years old and their mothers were 29 years and 8 months old when their sons were born. The fathers married at the average age of twenty-eight years, being somewhat more than five years older than their wives. The scientific men are consequently born at an average interval of seven years after the marriage of their parents. The ages are given separately for the four groups into which the scientific men have been divided and are earlier for both fathers and mothers (group I. in the table) of those more distinguished. The probable errors given in italics show that the differences may be due to chance, but that this is unlikely. It is the case, as shown

TABLE XII. THE AGES OF THE PARENTS AT THE BIRTH OF THE SCIENTIFIC MEN AND AT DEATH, ACCORDING TO THE STANDING OF THEIR SONS

	No.	Age at Birth of Scientific Man		No.	Age at Death	
		Father	Mother		Father	Mother
I.	64	34.02 ± *.57*	28.37 ± *.50*	62	70.18 ± *1.12*	70.89 ± *1.36*
II.	160	34.54 ± *.40*	29.86 ± *.31*	154	70.85 ± *.75*	70.68 ± *.78*
III.	505	35.00 ± *.23*	29.72 ± *.20*	496	70.77 ± *.38*	69.96 ± *.36*
IV.	136	35.69 ± *.53*	30.09 ± *.38*	121	70.91 ± *.92*	69.45 ± *.99*
Total	865	34.95 ± *.18*	29.70 ± *.15*	833	70.64 ± *.30*	70.20 ± *.31*

below in Table XIV., that the first-born son is the one most likely to become a scientific man, and the parents of first-born children are of course younger.

In Table XI. is also given the average age at death of the parents, whence it appears that the fathers died at the average age of 70.6 years, the mothers at 70.2 years, the chances being even that these figures are correct within a third of a year. The average age of the scientific men being about fifty years, most of their parents are no longer living. If, however, the deceased parents only had been included, the averages would have been too low, as the more long-lived parents would be those more likely to be living. The expectation of life has been added to the age of each of those still living, and the probable age at death used in the averages. The ages given do not mean that people of this class live to those ages, or that the men live longer than the women. A statistical error such as this has often been made, a distinguished scientific man having, for example, urged that it is one of the advantages of the scientific career that scientific men live much longer than the average, failing to note the circumstance that there are no scientific men who die when they are babies. The figures in the table mean that the fathers being on the average 35 years old when their sons are born have an expectation of life of 35.6 years, and will on the average die at the age of 70.6 years. The mothers, averaging 29.7 years old, have an expectation of life of 40.5 years. These expectations are about four years longer than those allowed by standard mortality tables, but the data are not exactly comparable. Although the parents of the more distinguished scientific men do not live longer than the others, they live longer after the births of their sons.

TABLE XII. THE AGES AT DEATH OF THE FATHERS OF THE SCIENTIFIC MEN IN ACCORDANCE WITH THEIR OCCUPATIONS

	No.	Age at Death
Professions....	370	69.67 ± .45
Clergymen	94	71.68 ± .81
Physicians	66	67.20 ± 1.08
Lawyers ...	57	71.75 ± 1.19
Teachers...	70	69.29 ± 1.07
Other.....	83	68.25 ± .92
Agriculture...	193	72.81 ± .62
Manufacture	330	70.65 ± .48
Total..	893	70.71 ± .29

Table XII. shows that the farmers who were fathers of scientific men died at the average age of 72.8 years, the physicians at 67.2 years, a difference of over five years between the shortest and longest lived of the groups. The clergymen and lawyers lived one year less than the farmers, the teachers two and a half years less. Those engaged in manufacturing and trade died at the average age. According to the report of

the English registrar-general (1908), the death rates per thousand during the years 1900–1902 for those between 45 and 65 in different occupations were: Farmers, 14.8; clergymen, 15.5; teachers, 15.8; lawyers, 18.3; physicians, 23.9.

Table XIII. gives the ages at death of the mothers in accordance with the size of their families. The crude figures are sub-

TABLE XIII. AGE AT DEATH OF MOTHERS OF THE SCIENTIFIC MEN IN ACCORDANCE WITH THE SIZES OF THEIR FAMILIES

Size of Family	1	2	3	4	5	6	7	8	9	10	11	12	Av.
Number.....	45	91	106	136	110	112	59	44	27	16	8	5	759
Age at death..	61.7	67.9	69.3	71.7	69.1	71.5	73	70.7	77.6	70.5	76.2	80.6	70.1
No. dying under 45.....	10	17	11	10	11	3	2	4	0	0	0	0	68
Age at death of those surviving 45...	68.6	74.2	73	74.4	72.5	72.5	74	73.6	77.6	70.5	76.2	80.6	73.3

ject to a statistical error, as mothers might have small families because they died early. This is eliminated by considering only those who survived the child-bearing age. In this case mothers of one child died at the average age of 68.6 years; mothers of 12 children at the age of 80.6. There are included 759 families, but the number of families of different sizes is too small to give entirely valid averages. Still it is significant that the thirteen mothers of 11 and 12 children lived to the average age of 78 years; the 43 mothers of 9 and 10 children to the age of 75 years. It is probable that the women who were the more vigorous had the largest number of children and also lived to the greatest age; they might have lived as long or even longer if they had been unmarried. Though largely due to statistical selection, the fact remains that of 45 mothers of one child 10 did not survive the age of 45, whereas of 56 mothers of from 9 to 12 children not one died under this age. In view of these facts it may be doubted whether the practise of limiting the number of children is beneficial to the health and longevity of the mother.

Table XIV. gives the numbers of scientific men who were first-born children, second-born, etc., for each size of family. A scientific man is of course more likely to be a first-born child than a second-born, because there are families with only one child and consequently more first-born children. But it appears from the table that the first-born child is more likely than the others to become a scientific man. In families of two or more children, 285 are first-born and only 168 second-born; in fami-

lies of three or more, 214 are first-born and 114 third-born; in families of four or more, 159 are first-born and 81 fourth-born.

The first-born child has been reported to be more likely to be a man of genius, an idiot, a consumptive and various other things, but usually as the result of some statistical fallacy. If, for example, in our figures only families of two and eight are considered, there being on the average five children and two first-born, it looks at first sight as though the chances are one in five that an individual selected at random would be the first-born. But both families being represented, it has been argued that the chances are half that the individual is the first-born in the small family and one eighth in the large family, or on the average five sixteenths, nearly one in three. However, the family of eight is four times as likely to be represented in a random selection from the two families, so the chances of the individual being first-born are reduced to one in five. Finally—and this seems to have been overlooked—there are three times as many families of two as of eight, and there are in fact 16 chances out of 61, or a little over one in four, that the individual selected at random will be the first-born.

TABLE XIV. THE ORDER OF BIRTH OF SCIENTIFIC BORN

	Order of Birth												
	1	2	3	4	5	6	7	8	9	10	11	12	
1	63												63
2	70	52											122
3	55	39	31										125
4	53	33	32	29									147
5	47	13	18	17	23								118
6	30	17	16	19	21	14							117
7	16	7	8	7	9	14	7						68
8	7	3	5	4	8	5	4	8					44
9	5	1	2	4	4	4	0	3	5				28
10	1	1	2	0	1	2	0	0	0	5			12
11	0	1	0	1	0	1	0	0	1	1	1		6
12	0	1	0	0	0	0	0	1	0	1	1	1	5
	347	168	114	81	66	40	11	12	6	7	2	1	855

These errors have been eliminated by the method used in the table, but there are at least two other statistical errors that affect such data. When we are dealing with contemporary families the older children may be preferred. Thus children under fifteen are not likely to suffer from pulmonary tuberculosis or to be criminals, and the patient or the prisoner may be more likely to be the first-born child than the last born. This circumstance holds for the scientific men. They are on the average 38 years old when they attain their position, and the scientific population is rapidly increasing, so the earlier born children are more likely to be included. This factor, however, is small, as is shown by the fact that the second-born child is not appreciably more likely to be a scientific man than those

later born. Probably a larger statistical error is introduced by the fact that a man sometimes does not know of or ignores children who were born and died before he himself was born, and thus records himself as the first-born.

In so far as it may in fact be the case that the first-born child is more likely to be a scientific man, this is probably due to social rather than to physiological causes. Galton found the eldest son to be preferred, and perhaps this might be expected under a system of primogeniture. In this country where families are apt to improve their economic condition, the younger sons may be more likely to be sent to college than the older, but as to this there is no available information.

In Table XV. the intervals are given between marriage and the birth of the first child and between the births of successive

TABLE XV. INTERVALS IN YEARS BETWEEN MARRIAGE AND BIRTH OF FIRST CHILD AND BETWEEN BIRTHS OF SUCCESSIVE CHILDREN

Size of Family	No.	1	2	3	4	5	6	7	8	9	Av.
1	70	3.17									3.17
2	121	2.14	4.21								3.17
3	120	1.87	3.09	4.00							2.99
4	56	1.59	2.40	3.16	3.82						2.74
5	29	1.62	2.52	2.69	3.38	3.76					2.79
6	12	1.33	1.83	2.00	2.92	2.25	2.75				2.18
7	5	1.40	2.00	1.60	2.60	3.00	2.00	2.20			2.11
8	2	2.00	1.50	2.50	2.00	2.00	2.00	2.00	3.50		2.19
9	1	1.00	2.00	1.00	2.00	2.00	1.00	3.00	2.00	2.00	1.78

children for families of different sizes. When there is only one child it is born on the average 3.2 years after marriage, whereas in a family of five or more the interval is about a year and a half. In the standardized family of two the second child is born 4.2 years after the first, twice as long as for large families. The delay in the birth of children in small families might be due to the same physiological or pathological causes which make the family small, but in most cases it is probably due to voluntary control.

From Table XVI. it appears that 478 scientific men had 716 sons and 660 daughters. This difference falls within the limits of chance variation, and is not likely to be significant. In the families from which 832 scientific men come there were 2,537 sons and 1,527 daughters. This disparity may at first strike the reader as inexplicable. Galton in his "Hereditary Genius" says: "I also found the (adult) families to consist on an average of not less than 2½ sons and 2½ daughters each. Consequently each judge has on an average of 1½ brothers and 2½

sisters. . . . 100 judges are supposed to have 150 brothers and 250 sisters." Nearly all those whom I have questioned about this statement think that it is correct. It seems to most people obvious that if there are equal numbers of boys and girls, a boy must on the average have one more sister than brother. As a matter of fact, however, a judge, a man of science or any other man, is likely to have not fewer but more brothers than sisters. 832 scientific men had 1,705 brothers and 1,527 sisters. Havelock Ellis finds 121 boys and 100 girls in the families producing British men of genius, and concludes that they "are the offspring of predominantly boy-producing parents"; this curious fact is further emphasized by the fact that families yielding women of genius "show a predominantly girl-producing tendency." A boy has as many brothers as sisters, owing to the sex composition of families. Thus in families of two, one fourth of the families will consist of two boys, one fourth of two girls and one half of a boy and a girl. On the average, four boys will have among them two brothers and two sisters, and there is a similar equality for larger families. A man is likely to have more brothers than sisters for the same statistical reason that he is likely to come from a larger family than he has. If a family consists of six boys, it is six times as likely to produce a judge as a family consisting of one boy and five girls. The judge or the scientific man is thus likely to have more brothers than sisters.

TABLE XVI. DISTRIBUTION OF SONS AND DAUGHTERS

Size of Family	No. of Families	Family of Parents		
		Sibs	Sisters	Brothers
(1)				
2	126	126	69	57
3	128	256	123	133
4	152	456	244	212
5	125	500	266	234
6	123	615	327	288
7	71	426	235	191
8	48	336	172	164
9	31	248	121	127
10	16	144	83	61
11	7	70	34	36
12	5	55	31	24
Total	832	3232	1705	1527
		Family of Scientific Men		
		Children	Sons	Daughters
1	81	81	42	39
2	136	272	153	119
3	130	390	199	191
4	63	252	130	122
5	41	205	104	101
6	15	90	46	44
7	5	35	16	19
8	4	32	10	22
9	3	27	16	11
Total	478	1384	716	668

Table XVII. contains information in regard to deaths in the families of scientific men. For their brothers and sisters the percentage of deaths recorded under five years is 14.8, and under twenty-five years it is 22.5. For their children the percentages are 7.5 and 10.9. The death rate has thus decreased to half in a single generation, and for the children of the scien-

tific men is probably the smallest known. As only completed families are considered, there are practically no children under five, but those under twenty-five who might die before reaching that age make the death rate too low in this group. It is difficult to see how more valid statistics can be obtained than those supplied by scientific men, the order of birth and the dates of birth and death having been given; yet it is undoubtedly the case that all deaths are not recorded, especially for the brothers and sisters who died in infancy. This error would, however, only emphasize the decrease in the deaths of the children as compared with the preceding generation. The number of deaths among a thousand children born is not directly comparable with death rates per thousand of the child population. When there are seventy-five deaths under the age of five among a thousand infants born to the scientific men, the annual death rate is somewhat larger than 15.

TABLE XVII. DEATHS IN THE FAMILIES OF SCIENTIFIC MEN

	Size of Family Brothers and Sisters 1 to 6	7 to 12	Tot. or Av.
Number of families.....	515	129	644
Brothers and sisters...	1406	917	2323
% of deaths under 5...	14.22	15.59	14.77
% of deaths under 25..	22.28	22.63	22.51
	Children 1 to 4	5 to 9	
Number of families.....	416	67	483
Children	1024	381	1405
% of deaths under 5...	7.37	8.01	7.54
% of deaths under 25..	10.69	11.55	10.93

The decrease in the infantile death rate in recent years is so remarkable as to be almost incredible, and the existing differences in nations and social classes are appalling. In the families from which our scientific men come, the death rate for children under five is somewhat over 30 and in their own families it is somewhat over 15. The rate in the registration area of the United States in 1900 was 51.9. In the present registration area it was 32.9 in 1911, varying from 41.1 in Massachusetts to 18.6 in Washington, from 74 in Fall River to 22.4 in Seattle. In or about 1900, the rates for other nations were:

Russia	134.5
Spain	104.1
Austria	86.7
Germany	74.2
Italy	74.8
England	53.5
France	47.6
Sweden	37.5
New Zealand	23.2

The table indicates a small selective death rate against the

larger families. When there were one to six brothers or sisters the percentage of deaths under five years was 14.2 as compared with 15.6 for larger families; when the number of children was four or less, the percentage was 7.4 as compared with 8 for families of five or larger. This small difference is probably due to the coinciding decrease in the birth rate and in the death rate. The larger families had a higher death rate not because they were larger but because they were earlier when the death rate was higher. Other statistics, such as those of Rubin and Westergaard for Copenhagen, show a selective death rate against the larger families. In the statistics with which we are concerned poverty and neglect are almost excluded.

In Table XVIII. is shown the relation between the size of the family from which the scientific men come and the size of

TABLE XVIII. THE RELATION BETWEEN THE SIZES OF FAMILIES OF THE PARENTS OF SCIENTIFIC MEN AND THE SIZES OF THEIR OWN FAMILIES

	Size of Parents Families				Tot. or Av.
	1, 2, 3	4, 5, 6	7, 8, 9	10, 11, 12	
Under 50.	94	110	37	12	253
Size of family.....	1.69	1.99	1.81	2.41	1.88
50–59.....	74	93	33	5	205
Size of family.	2.35	2.14	2.69	2.60	2.32
Above 59.....	43	61	31	4	139
Size of family.	2.60	2.77	2.48	4.00	2.70
No. of families.....	211	264	101	21	597
Av. size of families.	2.11 ±.11	2.22 ±.07	2.30 ±.13	2.76 ±.29	2.22 ±.06

the family that they have, the scientific men being divided into three age groups. It will be noted that the size of family of the scientific men varies with their age at the time, being 2.7 children when they are above 59; 2.3 when they are between 50 and 59, and 1.9 when they are under 50. These differences are partly due to statistical selection, the families of the younger men being not absolutely complete, and the barren and smaller families being more likely to be included. They, however, in part represent the declining birth rate within a period of twenty years. There is shown a slight positive correlation between the number of brothers and sisters and the number of children. Thus when a man comes from a family of 1, 2 or 3 children, his family averages 2.1, and as the size of the family from which he comes increases by groups of three, his own family increases to 2.2, 2.3 and 2.8. The probable errors show that the figures have a limited validity. The differences, how-

ever, may be due to the decreasing size of family, the older scientific men having larger families and coming from families which were larger because they were earlier. The inheritance of physiological fertility would depend partly and perhaps chiefly on the female, and the size of the modern small family is determined in the main by social and psychological causes. If the data here given were valid, they would show a slight correlation of fecundity in successive generations and a slight selective death rate against the larger family, which about balance each other. These conditions are those which must obtain in a state of nature, for unless there is a change in the environment, the number of individuals of a species can not considerably increase, and if they regularly decrease it will be exterminated. The relations which obtain in the families of scientific men are, however, probably due entirely to the decreasing death rates and birth rates of the past seventy-five years.

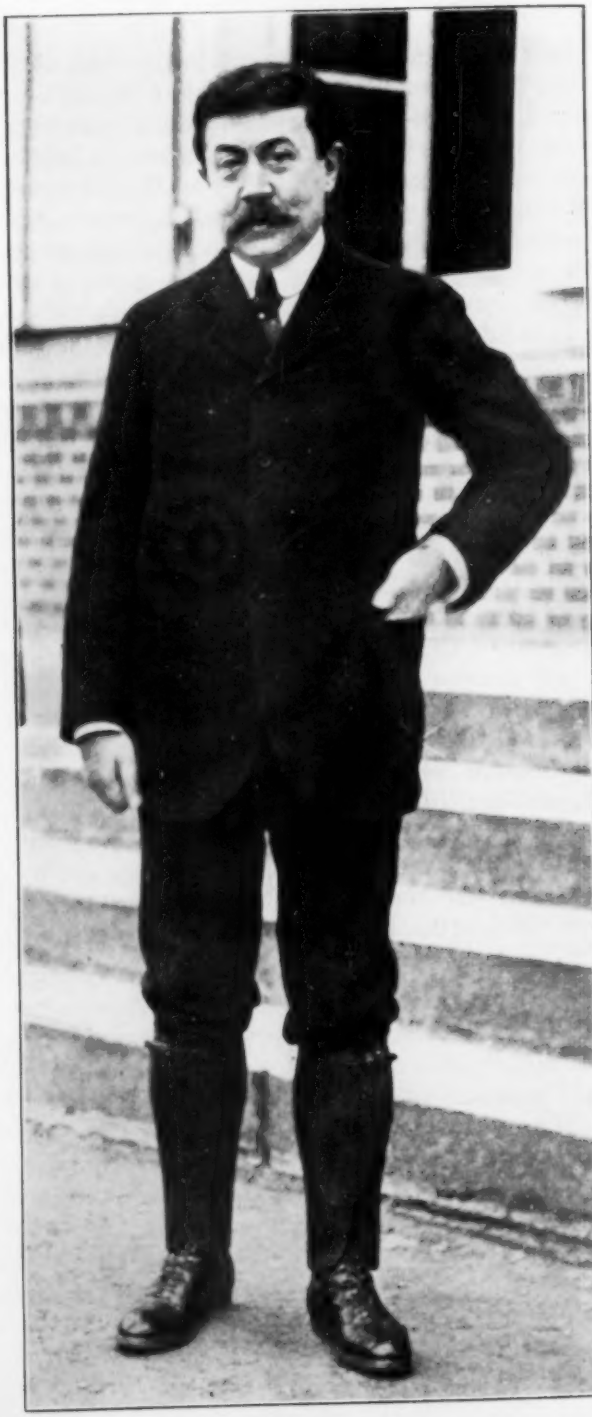
In Table XIX. the scientific men are divided into four groups in accordance with their distinction and the size of the family from which they came and which they have is given for each degree of distinction. The most distinguished group (I. in the table) came from families of the average size of 4.7 and have families of the average size of 2.5, in both cases above the average. The eminent man is slightly more likely to have more brothers and sisters and appreciably more likely to have more children than his colleagues. The most eminent group is, however, about five years older than the others, and this about accounts for their larger families, so rapid has been the decline in the birth rate. The lack of correlation between the distinction of a scientific man and the size of his parents' family may be due to a combination of causes. On the one hand, the only child or the child from a small family may be more likely to have educational opportunities or inherited wealth; on the other hand, he may have inferior heredity and opportunity for forming character.

TABLE XIX. THE STANDING OF SCIENTIFIC MEN AND THE SIZE OF FAMILY

	I	II	III	IV	Tot. or Av.
Parents' family					904
No. of families	71	162	530	141	
Average size...	4.73	4.59	4.69	4.45	4.64
Own family					554
No. of families	49	111	298	96	
Average size...	2.50	2.17	2.14	2.39	2.22

The conditions are similar for scientific men who are unmarried or who have no children or but one, as compared with scientific men with larger families. There is but slight differ-

ence in their performance. The similarity may be due to a balance of various conditions, and is also in part accounted for by the fact that men marrying at the average age of 29.5 years have in large measure had such original ideas as they may hope to have and have in the main determined their careers. As a matter of fact those who are unmarried furnish fewer men than the average to the two more distinguished groups while those with six or more children supply a larger number. If the figures for scientific men with the largest families could be regarded as valid, it would be indicated that they are the ablest and most successful, but at the same time furnish the largest share to the group who have dropped out of the first thousand, perhaps owing to the circumstance that scientific work must be neglected to support the children. But the differences are too small and the families are too few to permit any conclusions except that under existing conditions there is no appreciable correlation between the distinction of a scientific man and the size of family from which he comes or which he has. This fact itself is, however, of considerable social significance. The material handicap of the larger family is balanced by improved character and greater efforts or by the superior quality of the men coming from and supporting the larger family. In his study of "Heredity in Royalty" F. A. Woods finds that there is a direct correlation between intellectual and moral qualities and between moral qualities and size of surviving family. In this case the larger family is not a burden for the parents. It is reasonable to assume that if the cost of children could be borne by society for whose benefit they exist, there would be larger numbers of children having superior inherited ability.



PAUL PAINLEVÉ,

The Distinguished Mathematician, now Premier of France.

THE PROGRESS OF SCIENCE

FRENCH CONTRIBUTIONS TO SCIENCE

M. PAUL PAINLEVÉ, professor of mathematics at the University of Paris and of mechanics at the Paris Polytechnic School, has become premier of France in the present national and world crisis. Like M. Ribot, whom he succeeds, and M. Poincaré, the President of the Republic, who called on him to form the cabinet, he had been minister of public instruction. It is a curious commentary on our democracy that education is not represented on our cabinet, also that we do not have ministers of state, but only secretaries, named by the President to do his will. M. Ribot is a member of the French Academy. M. Poincaré is also an author of distinction and bears a name which has been made even more eminent in mathematics than Painlevé's by his cousin, Henri Poincaré, perhaps the greatest of modern mathematicians, and by his brother, Lucien Poincaré, the well-known physicist and mathematician.

M. Painlevé became a deputy only in 1914. Previously he was known as one of the group of mathematicians which made Paris the leading mathematical center of the world, including among its members Poincaré, Darboux, Jordan, Picard, Appell, Goursat, Hadamard and Borel. Mathematical analysis is a natural product of the clear and logical intellect of the French; it is of interest that it should be applied to the conduct of affairs of state. France is the most highly civilized of the nations and has used most freely men of scientific and intellectual parts in its government. But a highly organized and centralized civilization has the defects of its qualities. It remains to be seen whether the control by English gentlemen—represented by men such as Mr. Asquith, Mr. Balfour and Earl Grey, or the control by intellectuals, such as M. Ribot, M. Poincaré and M. Painlevé, will longest resist the flood of socialistic democracy.

There has recently appeared under the auspices of the Society for American Fellowships in French Universities a book entitled "Science and Learning in France" intended as a national homage offered from the universities of America to the universities of France. The work is edited by Dr. John H. Wigmore, professor of law in Northwestern University, and was prepared by distinguished authors representing different departments of science and scholarship. There is also printed a list of sponsors, nearly a thousand in number, professors in American colleges and universities, who in numbers and in contributions to science and scholarship compare favorably with names which could be selected for France or any other country.

President Eliot, in an introduction entitled "The Mind of France," calls attention to the cordial appreciation of intellectual achievement and particularly of scientific investigation by the French people. They have always placed high among their national heroes their great scholars, authors and men of science. American students, planning to study in Europe, have sometimes supposed, judging from certain aspects of Parisian life, that the French are an inconstant, pleasure-loving, materialistic people. The great mass of the

THE LABORATORY BUILDING OF THE BROOKLYN BOTANIC GARDEN.

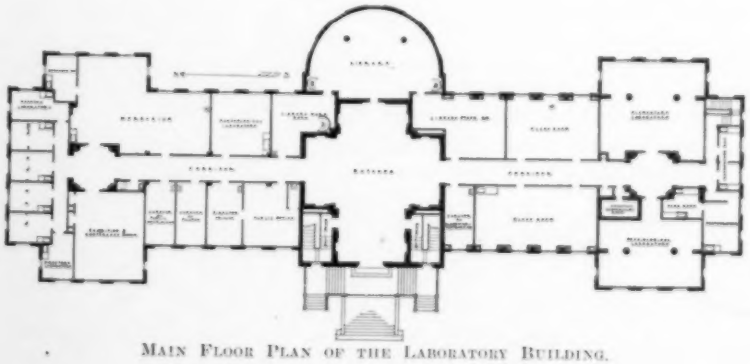
people are constant to great political and social ideals, intelligent and devoted to family, home and country. Dr. George E. Hale, the astronomer, and at present chairman of the National Research Council, writes on the intellectual inspiration of Paris, giving special attention to the work of Louis Pasteur. These introductions are followed by a series of articles beginning with anthropology, archeology and astronomy, and taking up in alphabetical order the main departments of science and scholarship. Each of the articles gives a brief description of French contributions to the subject, with special reference to the contemporary conditions at Paris and the provincial universities. There is finally given a full account of the educational advantages for Americans in France; a history of the recent changes in the university system; an account of the institutions of higher learning, their organization, degrees, requirements, fees, etc., and practical suggestions to students intending to take up graduate studies in France.

The great majority, probably more than nine tenths, of American students who have taken up work in foreign universities have done so in Germany. The universities of France and Great Britain have been too much neglected. In recent years the great development of American universities and the practical opportunities, offered by fellowships and promotion to positions have led most students to remain at home. It is, however, extremely desirable that there be a free exchange of students between our universities and those of the great European nations.

THE BROOKLYN BOTANIC GARDEN

THE completed laboratory building and plant houses of the Brooklyn Botanic Garden have been dedicated with addresses by Prof. John Merle Coulter, officials of the City of New York, of the Brooklyn Institute of Arts and Sciences, of which the garden is a department, and by the director of the garden, Dr. C. Stuart Gager. Scientific sessions were held on two days, papers were read by thirty-nine botanists representing twenty institutions.

An article on the initial development and plans of the garden appeared in *The Popular Science Monthly* for April, 1912. Since that date the grounds have been enlarged by the addition of about ten acres, bringing two of the entrance gates directly opposite stations on the new subway lines, thus making the garden one of the most easily accessible of the numerous scientific institutions in Greater New York. The



MAIN FLOOR PLAN OF THE LABORATORY BUILDING.

IN THE BROOKLYN BOTANIC GARDEN.

completion of the laboratory building and plant houses, at a cost of over $285,000, was made possible by a private gift of $100,000.

In planning the building and grounds, and the character of the conservatory collections, there has been constantly kept in mind the broad aims of the garden, as tersely expressed by the phrase, "the advancement of botany and the service of the city." A scientific institution, supported in part by public taxation, not only enjoys opportunities, but has certain definite obligations to make direct returns to the community that supports it. The science of botany must not only be advanced by research, but the fruits of investigation should be interpreted to the general public in a reliable manner, and in terms that laymen can understand. Nothing hampers the financial support of scientific research more than the ignorance of the general public as to its nature and its value to mankind.

The plantations comprise the following sections: systematic, local flora, morphological, ecological, evolution and plant breeding, economic, and formal and other special sections. The unique feature of the systematic section, occupying about five acres, is the combination of the herbaceous garden with the fruticetum. Beds of herbaceous plants are grouped in orders, and each ordinal group is enclosed by a planting of the shrubs botanically related to the plants in the beds. The educational value of such an arrangement is very great, making it possible to bring out relationships and contrasts not possible where the fruticetum is developed as a feature apart.

The local flora section has proved to be of great popularity, and has been a valuable factor in the propaganda for the preservation of our native wild flowers. Among the special garden features may be mentioned the Japanese garden (pronounced by Japanese critics as the finest garden of its kind in a public park in America), and the rock garden, the only garden of its kind accessible to the general public in Greater New York, and one of a very few public rock gardens in the United States.

The conservatory collections are developed along two lines—systematic and economic. The economic house has been especially appreciated by local schools in connection

with their nature study and geography. Provision is made for a mushroom cellar, for the display of both edible and poisonous species; and there are four cases for liverworts, mosses and filmy ferns. One range of greenhouses is devoted to the elementary instruction of children, and the classes for the preparation of gardeners and garden teachers. One plant house is devoted to investigation.

The north end of the laboratory building, and a portion of the south end, are planned primarily for the accommodation of research. In this work special emphasis will be laid on the experimental phases of botany, including physiology, genetics and pathology. There are eight private research rooms, four general laboratories, a sterilizing and culture room, two class rooms, herbarium, library, experimental dark room, photographer's suite, a children's room, and a lecture hall seating five hundred and seventy. Offices of administration occupy a portion of the main floor.

The scientific staff at present numbers eight, of curatorial rank, with one resident investigator and one research fellow. The garden publications include an administrative quarterly (the *Record*), *Contributions*, a series of popular *Leaflets*, *Seed List* (annual), and the *American Journal of Botany*. The latter is published in cooperation with the Botanical Society of America. The first number of a series of scientific Memoirs is now being edited for publication.

In the way of serving the local community it may be mentioned that according to the *Sixth Annual Report* of the garden, over 14,000 children and adults attended regular garden classes, in addition to over 8,500 pupils from local schools who visited the garden with their teachers under the guidance of a garden docent, and also in addition to nearly 6,500 who attended public lectures.

As an illustration of one kind of service that botany can render in the stress of war, attention may be called to the fact that a large portion of the Botanic Garden grounds have, this year, been temporarily devoted to war gardens. Over 400 individuals are now cultivating these gardens, the individual plots varying in size from 8×10 feet to 20×40 feet. The garden has also assumed responsibility for starting and inspecting, during the growing season, over one hundred vacant lot gardens in Brooklyn, varying in size from a city lot to several acres. The entire time of one gardener, so far as needed, has been devoted to this work, and thousands of copies of popular pamphlets have been distributed on various phases of gardening, garden pests, preserving the surplus crops, and other related topics.

In short, the Brooklyn Botanic Garden has sought at every point to do two things: (1) to be directly useful to the community that supports and fosters it; (2) to advance and diffuse a knowledge and love of plants. Experience has shown that each of these lines of activity reacts favorably upon the other. The extension of the scientific work is contingent only upon an adequate endowment for that purpose, for, while the city largely (but not wholly) meets the annual cost of maintenance, the garden is chiefly dependent upon private funds for investigation and publication.

SCIENTIFIC ITEMS

WE record with regret the death of Adolf von Baeyer, professor of chemistry at Munich, distinguished for his work on synthetic indigo and in other directions, and of Eduard Buchner, professor of chemistry at

Würzburg, who died from wounds while serving as major at the front. Dr. Buchner was distinguished for his work on the chemistry of fermentation, and was the recipient of the Nobel prize for chemistry in 1907.

A NEW pedestal for the bust of John Muir has been made at the University of Wisconsin to be placed in the Building for Biology, where the bust of Muir was recently unveiled. The pedestal bears the inscription:

JOHN MUIR, 1838–1913
AUTHOR, EXPLORER, NATURALIST
A PRIEST AT NATURE'S SHRINE.

THE President has ruled that medical students and hospital internes who are drafted may be discharged from the national army to enlist in the Reserve Corps of the Medical Department and will be permitted to complete their medical course. By order of the surgeon-general the following letter has been written to the editor of this journal: "In reply to your communication of August 15 requesting information relating to drafted men who possess scientific training, I beg to advise you that the Sanitary Corps of the United States Army, attached to the Medical Department, will accept a number of selected men who are not physicians, but who have attained professional standing in bacteriology, chemistry and the several branches of engineering pertaining to sanitation. The Corps was organized specially to secure the services of skilled sanitarians having experience in both practical field work as well as those specially qualified in the several scientific branches having a correlation to the sanitary sciences."

THE Nitrate Supply Committee, appointed by the Secretary of War, has recommended that contingent upon satisfactory arrangements with the General Chemical Company, out of the $20,000,000 nitrate supply appropriation such sum as may be needed, now estimated at $3,000,000, be placed at the disposal of the War Department to be used in building a synthetic ammonia plant, employing the said process of the General Chemical Company, and of a capacity of 60,000 pounds of ammonia per twenty-four-hour day, said plant to be located in a region where land, water, coal and sulphuric acid are cheaply available, where good transportation facilities exist, and where the proposed new powder plant of the government can be properly located. In the opinion of this committee all of these conditions are best fulfilled by a location in southwest Virginia or contiguous region.